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Does Localized Myocardial K_{ATP} Channel Opening Result in Global Cardiac Instability?

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ABSTRACT

Ischemic preconditioning (IP) is a well described physiologic mechanism that protects myocardial tissues from repeated ischemic insults through K_{ATP} channel opening. Previously, this IP process has been thought to be a constrained to a local phenomenon that is mediated through indigenous biochemical adaptations. Recent evidence indicates that the cardioprotective effects of ischemic preconditioning (IP) may be systemically mediated and can influence distant tissues. However, it is uncertain if these global effects are necessary to maintain general circulatory integrity. D-Ala2-Leu5-enkephalin (DADLE), a δ-opioid receptor agonist, is known to induce an IP state including K_{ATP} channel opening. In this study we examined the effects of DADLE restricted to a localized segment of myocardium on overall cardiac and circulatory stability. A myocardial ischemia-reperfusion protocol was performed in pigs in which the left anterior descending coronary artery (LAD) was ligated distal to the 1st branch in order to isolate a section of myocardium. During the occlusion period, DADLE was infused into the distal LAD (D pigs). Hemodynamic data including continuous rhythm monitoring and 12 lead EKGs were collected before and after the initiation of the DADLE. Relative arrhythmia frequency and QT dispersion (QTdisp) were compared to a control group without DADLE (C pigs). In a total of 12 pigs studied (6 D pigs ; 6 C pigs), 83% of the D pigs and 17% of the C pigs developed sustained ventricular arrhythmias after the infusion period. The D pigs incurred a 116% increase in the amount of QTdisp over the preocclusion period as compared to only a 22% increase for C pigs. IP through a mechanism of K_{ATP} channel opening is cardioprotective and limits local myocardial tissue necrosis. However, when this effect is confined to a limited area of the heart, segmental delays in repolarization may produce global cardiac electrical instability. The findings of this study support recent evidence suggesting that IP is a complex process with systemic as well as local mechanisms of action.

Keywords: K_{ATP} channel opening, ischemic preconditioning, QT dispersion, DADLE

INTRODUCTION

Ischemic preconditioning (IP) refers to an endogenous protective mechanism of the localized myocardial tissues to limit the damage and infarct size of a subsequent ischemic event (1). It is thought to be induced by preceding short periods of ischemia that "precondition" the myocardial tissue through indigenous biochemically-mediated adaptations (1). IP is thought to be mediated by δ-opioid receptor stimulation and induction of K_{ATP} channel opening (2,3,4). Recent studies have provided evidence that the cardioprotective effects of IP may be systemically mediated, triggered by some humoral compound that can influence distant tissues (1). While this compelling finding has some exciting potential from a therapeutic standpoint, it also raises many new questions that are fundamental to our understanding of the mechanisms of ischemic preconditioning. Is this coronary effluent simply a spillover of the local preconditioning or is this newly discovered "action at a distance" also an important part of the protective mechanism? From both a scientific and medical perspective it is important to ascertain if these global effects are necessary to maintain general cardiac and circulatory integrity. In an effort to answer this question a porcine model was developed in which a segment of myocardium and its coronary supply could be isolated from the remainder of the cardiac tissue. D-Ala2-Leu5-enkephalin (DADLE), a δ-opioid receptor agonist known to induce a state of K_{ATP} channel opening similar to the mechanisms of IP, was infused into the distal segment of the left anterior descending artery (LAD) during an acute coronary occlusion to examine the effects on overall cardiovascular stability (2). IP through a mechanism of K_{ATP} channel opening is cardioprotective and limits local myocardial tissue necrosis. However, when this effect is confined to a limited area of the heart, segmental delays in myocardial repolarization may produce global cardiac electrical instability.

DADLE: IP is thought to be may be mediated by δ-opioid receptor stimulation and induction of K_{ATP} channel opening (3,4). DADLE is a δ-opioid receptor agonist that has been extensively studied with regard to its effect on myocardial cell function and has been used as a tool to investigate the mechanisms of IP (2,5). In fact, δ-opioid receptor agonists have been shown to limit infarct size and lower myocardial oxygen consumption (6,7). Additionally, it is thought by some investigators that an endogenous compound similar to DADLE may be the cardioprotective link between preconditioning and natural hibernation in animals (2). These factors make DADLE an excellent tool for simulating a state of localized IP. While δ-opioid receptor blockade has been found to have an antiarrhythmic effect during acute coronary occlusions, systemic infusions of DADLE are not arrhythmogenic and have no effects on the electrocardiogram during coronary occlusions (5,8).

MATERIALS AND METHODS

All experiments were conducted in anesthetized male or female pigs weighing 22±1 Kg. The experimental protocol was approved by the Institutional Animal Care and Use Committee of the University of Mississippi Medical Center and experiments were conducted according to the *Guide for the Care and Use of Laboratory Animals* and the guidelines of the Animal Welfare Act.

Approximately 15 minutes prior to anesthesia, all pigs were administered atropine (0.025mg/kg i.m.), meditomidine (0.08mg/kg i.m.), and butorphanol (0.2mg/kg i.m.). Anesthesia was induced with ketamine (10mg/kg i.m.), the pigs intubated, and anesthesia maintained with isoflurane. An ear vein was cannulated and saline infused at 10 ml/kg/hour. A femoral artery was catheterized and used for measuring arterial pressure, pulse pressure, heart rate and DP/dt and for sampling systemic arterial blood.

In a restricted myocardial ischemia-reperfusion protocol, a segment of the myocardium and its blood supply were isolated from the remainder of the heart by a ligation of the left anterior descending coronary artery (LAD) just distal to the 1st branch. In the operative procedure, the heart was exposed via a midline sternotomy, the pericardium retracted, and the LAD isolated and dissected free of surrounding tissues approximately 1/3 from the apex. A silastic tube was placed under the LAD and positioned to allow free flow of blood in the coronary. A 20-gauge needle was placed in the non-occluded LAD just distal to the ligature and perfused with heparinized whole blood at the very slow rate of 1 ml/min so as to limit the quantity of the perfusate released into the general circulation.

The animals were allowed to recover from surgery for at least 30 minutes and until the measured hemodynamic variables had reached a stable baseline, and then baseline control data were collected for 20 minutes. The LAD then was occluded by retracting the silastic tubing and placing a bulldog clamp on the LAD immediately proximal to the tubing. A 20-gauge needle was placed into the lumen of the LAD immediately distal to the occlusion, and 10 ml heparinized whole blood, with (Dpigs) or without (Cpigs) DADLE (Peninsula Laboratories Inc.; 1 mg/kg estimated heart weight) was infused into the LAD over 10 minutes at 1 ml/min. The infusion was stopped, the needle removed, and the occlusion continued for an additional 50 minutes. The occluder and clamp were then removed, followed by a 120-minute reperfusion period or until the animal expired. Reperfusion was determined visually by observing that blood flow to the blanched zone was reestablished. At the end of the reperfusion period, the LAD was reoccluded and a 10 ml bolus of Evan's blue dye infused into the left atrium. The heart was stopped with KCl, removed, and visually examined to verify that only a limited area of the myocardium had been isolated. The hearts were then stained with tetrazolium and infarct size determined with planimetry (9).

During the experiment, the measured hemodynamic variables were sampled at 200 Hz for 12 seconds of each minute, were averaged for this 12-second period, and were collected and digitally converted for analysis by computer. The cumulative average values of these hemodynamic variables were calculated for the different periods for each group (Dpigs and Cpigs) up through the completion of the 10-minute LAD infusion period during LAD occlusion. Data were excluded for analysis during periods of terminal dysrhythmia.

A standard 12-lead EKG was recorded at 25 mm/sec twice during control and several times during the occlusion and reperfusion periods. QT dispersion (QTdisp) was measured with standard technique from the EKG (10). Blinded measurements of the QT intervals (onset of QRS to end of T wave) were determined manually with calipers under magnification (6x). Three consecutive cycles were measured in each of the 12 leads, averaged to obtain a mean QT interval, and corrected for heart rate (R-to-R interval) using Bazett's formula ($QTc = {}^{QT}/_{\sqrt{RR}}$). When the end of the T could not be identified the lead was excluded. A minimum of 6 leads was required for the measurement of QT dispersion. The QT dispersion was calculated as the difference between the minimum and maximum QT intervals within the 12 leads. All episodes of sustained (> ventricular tachycardia (> 30 seconds) or prolonged ventricular arrhythmias requiring cardioversion were recorded. The experiment was terminated after 3 unsuccessful attempts at cardioversion. The relative arrhythmia frequency, degree of QT dispersion, and other hemodynamic variables were compared between groups using Fisher's Exact and t-test ($p < 0.05$).

RESULTS AND DISCUSSION

In a total of 12 pigs studied (6 Dpigs; 6 Cpigs), 83% of the Dpigs (5 out of 6) and 17% of the Cpigs (1 out of 6) there developed a sustained ventricular tachyarrhythmias within 5 minutes after the infusion of DADLE or sham control into the localized segment of myocardium (Table 1). These dysrhythmias quickly resulted in death of the animal despite repeated attempts at cardioversion. The average QTdisp at the end of the infusion period was found to be 144 msec (95% CI: 107;183) for the Dpigs as compared to 61 msec (35;84) for the Cpigs. When compared to the preocclusion measurements, this represented a 116% increase in the amount of QTdisp over the occlusion period for the Dpigs as compared to only a 22% increase for Cpigs.

Table 1. Comparison of the number of pigs with sustained ventricular tachycardia and the average QT dispersion (QTdisp) and the average percentage increase over control baseline values of QTdisp in control and DADLE infused pigs during coronary occlusion. QTDisp was calculated from 12 lead EKG records requiring a minimum of 6 leads. QTcAVG is the average QT interval corrected for heart rate on these EKGs during the occlusion period.

Group	No. With Sustained Arrhythmia	Average No. of EKG Leads	QTcAVG Msec (95%CI)	Avg QTdisp After Infusion	% Increase QTdisp
Dpigs (n = 6)	5 (83%)	6.8	575(524,613)	144 msec	116 %
Cpigs (n = 6)	1 (17%)	7.2	673(644,689)	61 msec	22 %

The cumulative averages of the different hemodynamic variables over the entire occlusion and infusion period showed stability as compared to their control period average values in the Dpigs (Table 2). However, in the Cpigs a small fall in the mean arterial pressure, pulse pressure and DP/dt were noted during the occlusion and infusion periods. While some of the variations observed are typical of the adrenergic stimulation seen during acute coronary occlusion, these small differences in the percent of deviation from control values were not felt to be hemodynamically destabilizing. Nonetheless, it is important to note that the average DP/dt (an indicator of contractility) fell significantly during the occlusion and infusion period for the Cpigs (-20%) while it remained stable for the Dpigs receiving DADLE during this same period.

Though the tetrazolium staining demonstrated a localized ongoing infarction of myocardium within animals from both groups, the failure to obtain a reperfusion period in 80% of the Dpigs made any reasonable comparisons impossible. However, in those animals that had a sufficient reperfusion period (5 Cpigs, 1 Dpig), infarct size measured an average of 13.8% of the volume of the left ventricle tissue (:5.45;22.15).

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Table 2: Comparison of the hemodynamic effects of coronary occlusion and infusion of DADLE vs control sham reported as percent of control period average. Mean Pressure (mmHg of arterial); Heart Rate (beats/min); Pulse Pressure (mmHg); DP/dt (mmHg/sec) are the averages over their respective periods.

GROUP	**Mean Pressure (95%CI)**	**Heart Rate (95%CI)**	**Pulse Pressure (95%CI)**	**DP/dt (95%CI)**
Dpigs control	63 (61,64)	104 (98,109)	32 (30,35)	716 (671,762)
Dpigs occlusion	63 (58,68)	109 (106,112)	31 (30,32)	699 (679,720)
% of Control Dpigs	***100 %***	***104 %***	***97 %***	***98 %***
Cpigs control	66 (65,68)	86 (83,89)	34 (33,35)	523 (476,570)
Cpigs occlusion	59 (58,60)	86 (85,87)	27 (26,28)	402 (385,420)
% of Control Cpigs	***89 %***	***100 %***	***79 %***	***77 %***

DISCUSSION AND CONCLUSIONS

Multiple studies in both the cardiology and emergency medicine literature have established that IP through a mechanism of K_{ATP} channel opening is cardioprotective and can limit myocardial tissue necrosis (1,11). The excellent work of Dickson, Przklenk and others has provided evidence that suggests IP is mediated through a humoral factor with the potential for "action at a distance" (1,11). While this finding can have enormous medical implications for the development of therapeutic strategies for patients with acute coronary occlusions, the physiologic significance of this discovery is still a mystery. Mammalian physiology is replete with systems of biochemical messengers that affect feedback and control in response to some stimulus. The majority of these messengers or triggers have very short half-lives and are designed to exert only localized effects within a tissue, organ or vascular bed (i.e. adenosine, cyclic AMP). However, when these blood-borne triggers cause an effect that is systemic or global in nature by an "action at a distance" these compounds fall into the class of biologic substances we call hormones. The fact that IP produces a substance that has the potential of exerting systemic effects requires us to question the physiologic importance of this action if we are to really understand the functioning of the cardioprotective mechanism.

In our study we were initially quite surprised to find that when δ-opioid receptor stimulated K_{ATP} channel opening (simulating the IP state) is confined to a limited area of the heart, segmental delays in repolarization may produce global cardiac electrical instability. This is in stark contrast to prior evidence demonstrating a lack of arrhythmogenesis and no effect on the electrocardiogram during coronary occlusion when DADLE is infused systemically and has the opportunity for global effects (5). It could be argued that the coronary occlusion and myocardial ischemia was responsible for the arrhythmias seen in our study. However, the overwhelming propensity of the dysrhythmic events to occur after the DADLE infusion, as opposed to the control period, makes that consideration very improbable. In fact, the pigs receiving DADLE were shown to have a preservation of myocardial function (DP/dt) during the occlusion period as compared to the control group despite the comparatively lower survival rate. It is also possible that there could be some washout of the DADLE into the general circulation in spite of the extremely low coronary infusion rate. However, no significant systemic hemodynamic effects of DADLE (bradycardia, hypotension) were noted and the quantity infused was well below that required to maintain physiologically effective blood levels (7). In IP the initial ischemia stimulates production of the humoral substance, which is washed out into the general circulation and prepares the myocardium for the next ischemic event (1). In our model there were no washout periods.

While the baseline mean arterial pressure and pulse pressures were similar for the controls of the two groups, there were significant differences in the control heart rates and DP/dt. It is uncertain what impact this discrepancy might have on the outcomes observed and could be considered a limitation of the study. It is possible that the increased contractility and heart rate also increased the basal myocardial oxygen demand in the DADLE group and resulted in relatively more ischemia during the occlusion period. However, the contractile state was preserved in the DADLE group while the coronary occlusion diminished the cardiac pumping capacity of the control pigs with some hemodynamic instability.

Overall, the findings from this study in conjunction with the previous studies cited suggest that IP is a mixed process with systemic as well as localized mechanisms of action. Examining this phenomenon in light of the evidence presented by Dickson, it is possible to hypothesize that IP must by necessity occur at the systemic level and affects the entire heart and not just the ischemic segment. The myocardium is a complex interplay of electrical and mechanical activity that must function in concert at the both the cellular and organ levels in order for the organism to survive. When ischemia occurs in a localized area of the heart, the segmental cellular elements are forced to down-regulate their metabolic demands and stabilize their membranes in order to mitigate the potentially destructive results of the insult. The heart that is best prepared for this adaptation (i.e. ischemic preconditioning through K_{ATP} channel opening) is most likely to survive. Because the electrical as well as the contractile functioning of this ischemic myocardial segment are linked to their metabolic integrity then their functioning also must be impacted. If this results in a change in membrane stability and K_{ATP} channel opening occurs only in the localized area it is easy to see how this could cause dispersion in the global electrical events of the heart. Such dispersion in repolarization of greater than ~80 msec is known to result in dysrhythmias and ventricular tachycardia (10,12). If the effects of the DADLE were present within the whole heart then this dispersion would be less likely to develop. Ovize et al. found a shortened time to fibrillation in pigs using a similar occlusion protocol to our study but with natural ischemic preconditioning (13). However, this tendency to fibrillation may not be mediated through changes in the KATP channels (14). There may be other factors related to the δ-opioid receptor agonist effect of DADLE that could destabilize the local myocardium. Wu et al. found a reduction in dysrhythmias after coronary artery bypass graft when IP was induced by a protocol that involved a clamping of the aorta (15). This is IP intervention was evidently more global in nature and would therefore have an effect on the entire.

There are several limitations to the study that should be noted. It could be argued that the coronary occlusion and myocardial ischemia was responsible for the arrhythmias seen in our study. However, the overwhelming propensity of the dysrhythmic events to occur after the DADLE infusion, as opposed to the control period, makes that consideration very improbable. In fact, the pigs receiving DADLE were shown to have a preservation of myocardial function (DP/dt) during the occlusion period as compared to the control group despite the comparatively lower survival rate. It is also possible that there could be some washout of the DADLE into the general circulation in spite of the extremely low coronary infusion rate. However, none of the typical systemic hemodynamic effects of DADLE (bradycardia, hypotension) were noted and the quantity infused was well below that required to maintain physiologically effective blood levels (16). In IP, the initial ischemia stimulates production of the humoral substance, which is washed out into the general circulation and prepares the myocardium for the next ischemic event (1). In our model there were no washout periods.

The effect of the physiologic mediators of IP to have an effect globally may be necessary for survival of the organism as a whole and therefore has strong evolutionary pressures for development. It is well recognized that DADLE may be protective against ischemia in a variety of organs other than the heart. It appears that there is still much we do not understand about IP and the area remains an exciting field for investigation (17).

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Survey of Oral Hygiene Knowledge and Practice Among Mississippi Nursing Home Staff

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ABSTRACT

We surveyed nurse's aides, certified nursing assistants, licensed practical nurses, and registered nurses working in nursing homes in Mississippi to determine practice, attitudes and knowledge related to dental hygiene and oral care. Demographic data was collected and a survey of oral health was administered. Thirty Mississippi nursing homes were randomly selected and 945 individuals completed the survey. Although 84% of respondents reported good to excellent knowledge of oral health, only 63% correctly answered more than 60% of oral health questions. Surprisingly, staff members (85.8%) reported some formal lectures dedicated to oral care. Less than 40% of staff assisted residents with brushing teeth once per day and only 13% of residents received assistance with daily flossing. Though nursing staff reported adequate time, personnel, and administrative support, the level of knowledge and degree to which the staff translated that knowledge into practice of oral hygiene was self reported as inadequate.

INTRODUCTION

In America today, people are living longer and retaining their teeth longer, resulting in greater dental and overall health issues for the general population, but specifically the nursing home resident (1). It is estimated that one in five individuals in the United States (U.S.) will be sixty-five years and older by 2050 (2, 3). The same demographic studies also suggest that those over the age of 85 will account for 4.5% of the population in the next half century (4). In 2005, 12% of the Mississippi population was sixty-five years old (5). Of the residents in Mississippi nursing homes in 2005 17.2% were sixty-five years to seventy-four years, 35.2% were seventy-five years to eighty-four years, and 35.7% were older than eighty-five years old (5). Furthermore, it has been estimated that 73% of nursing home residents currently retain at least some of their natural teeth, and that the number of edentulous (without teeth) residents living in nursing homes has decreased by 80% since 1980 (6).

Progress of dental care in the general population has led to unprecedented "good" dental health in the aging population; however if the oral healthcare needs of the nursing home residents are not met by the nursing staffs, multiple health issues could develop (1). The "Baby Boomer" generation (1946-1964) is the first generation of children who benefited from fluoridated water and toothpaste, an awareness of the importance of annual dental check-ups, and dental hygiene education in the classroom and through the media. Consequently this generation is more likely to retain its natural dentition than previous generations (7, 8, 9). As a result of improved oral practices and the greater likelihood of residents retaining their natural dentition, nursing home staffs will face growing challenges for the nursing home populations' oral care (10).

Current research shows that those living in nursing homes often lack appropriate dental hygiene care (11). Nursing homes and assisted living facilities often lack sufficient personnel with appropriate knowledge and practice skills, physical facilities, and financial support to meet this growing demand for appropriate dental hygiene (12). Consequently, residents in nursing homes could possibly have inadequate oral care, which will only increase as the number of residents doubles by 2020 (13).

RESEARCH METHODS AND STUDY DESIGN

The research design for this study involved describing and analyzing the population of the nursing staff in rural- and urban-based nursing home facilities in Mississippi. This is the first comprehensive research study in Mississippi to examine oral care in this confined elderly population. The survey included both a 10-question demographic component to identify variables in the survey population and a formal survey specifically related to oral care. The latter, a 53-question survey instrument, tested the attitudes, knowledge, and practice of oral care in nursing homes. The nondemographic portion of the survey included validated questions from four different sources (14, 15, 16, 17, 18) that were modified for this project. The oral health practice, attitude, and knowledge of nursing staff were assessed using self administered questionnaires. Some practice questions were recoded into correct/incorrect responses based on ADA recommended standards. Others were on a 4 point Likert scale of "never", "seldom", "frequently", and "always" with "never" scored as -1, "seldom/frequently" as 0, and "always" as +1. Responses on a 5-point Likert scale to 9 statements on oral health care (including nursing staff's own oral health) tested attitudes. Positively worded statements scored from +2 for ''strongly agree'' through zero for ''no opinion'' to –2 for ''strongly disagree''. Negatively worded statements were reverse-coded. The main outcomes were composite knowledge and attitudes scores. Knowledge was tested by true/false responses to 33 statements, each correct answer scoring one.

The investigator ensured the content validity of the survey instrument by following Carmines and Zeller's (19) guidelines. These authors describe three types of validity: criterion, content, and construct. Criteria refers to a statement of need, rules, standards, or tests that must be used in evaluating research, in this project the American Dental Association (ADA) Standards. Specifically, these include twice daily tooth brushing and once a day flossing for patients retaining their dentition. The ADA does not have a specific protocol for edentulous patients. Content validity is the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose. The term construct refers to the concept, attribute, or variable that is the target of measurement. Prior to deploying the instrument, a review panel of physicians, dentists, nurses, dental hygienists, and laypeople were asked to complete the survey to ensure face validity (20). Additionally, this prescreening indicated the estimated time of completion for the instrument.

Fifty-three questions on the nursing home survey targeted the practices, attitudes, and knowledge of the staff. The participants recorded their responses on a scan sheet with a number 2 pencil, and they were collated electronically in an Excel spreadsheet. The survey instrument was divided into sections: The first 10 questions concerned the nursing staffs' oral care practices; questions 11 through 19 determined their attitudes toward oral care, both their clients' and their own; and questions 20 through 53 queried their oral care knowledge. Some of the questions related primarily to practice to determine the level of oral care that the nursing staff provided, and the responses to these yes/no questions were reported as percentages. The responses to the questions on attitude were not necessarily deemed as correct responses, but rather as a spectrum of choices with regard to outlook. Other questions, especially those on knowledge, contained both correct responses and distracters to ascertain the knowledge of standard of care.

The researcher selected the survey population from the Mississippi Nursing Home Certification Register of 2007, which was available from the Mississippi Nursing Home Registry through the Mississippi Board of Nursing Home Administrators (21. However, the information is no longer available at this site and can now be found at MembeoftheFamily.net. The investigator administered the 63-question survey (which included both demographic and content questions) to the nursing staffs in 30 randomly selected nursing homes.

The U.S. Census Bureau (22) classifies as "urban all territory, population, and housing units located within an urbanized area or urban cluster" (para. 4). These are core groups or blocks that have a population density of approximately 1,000 people per square mile. A rural area consists of all territory, population, and housing units located outside of urban areas and urban centers. Of the 30 Mississippi nursing homes that were selected for survey, by definition, 15 were rural and 15 were urban.

RESULTS AND DISCUSSION

Demographic Characteristics of Mississippi. The demographics of Mississippi influence nursing home care and the composition of staff, making these statistics relevant to the current study. Mississippi is the fourth most rural state in the United States, and by most measures, the poorest and unhealthiest state in America. Mississippi ranks 50th in per capita income and 50th in overall health (23, 24). Furthermore, Mississippi health care problems are compounded by the lack of educated and trained healthcare providers.

It is pertinent at this point to provide a brief snapshot of Mississippi in terms of race and ethnicity, education and training, poverty levels, and dental health. The population is slightly greater than 2.9 million with 60.9% Caucasian, 37.2% African American, 2.2% Hispanic, and less than 1% Asian (23, 24). The United States Census reports that high school graduates under the age of 25 years comprise 71.4% of Mississippi graduates, compared to the national average of 84% graduates (23, 24). In Mississippi, 16.9% of college students complete a bachelor degree, which is 8% lower than the national average (23, 24). The median income for a Mississippi family is $15,853/year compared to $21,587/year nationally. Overall, 23% of the population in Mississippi lives below the poverty level. A total of sixty of eighty-two counties in Mississippi have poverty levels below the national average (Figure 1).

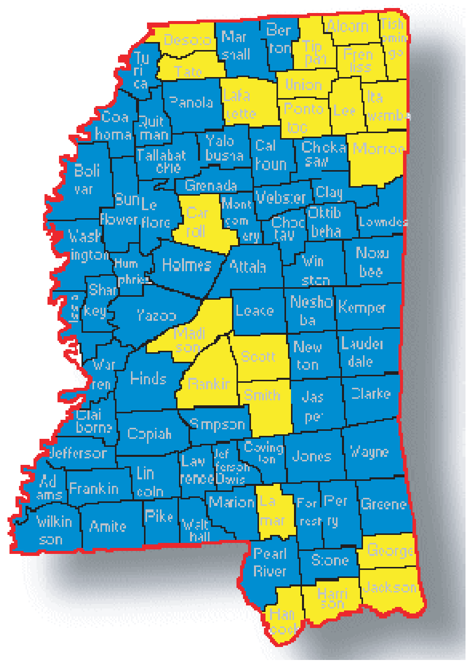


Figure 1. Poverty in Mississippi. Of the 82 counties in the state, 26.8% (22) are above the national poverty level while 73.2% (60) are below the national poverty level.

Especially relevant to this study are the statistics concerning oral health in Mississippi (24). Only 59.4% of adults in Mississippi visited a dentist or dental clinic in 2008 compared to 71.3% nationally. Routine prophylaxis by dental health professions was obtained by only 56.5% of adult Mississippians compared to 68.4% adults nationally. Of the population over 65 years of age, 27.3% in Mississippi are edentulous compared to 18.5% nationally.

Staff Demographics of Mississippi Nursing Homes. A total of 945 nursing staff responded in this study. There were 483 (51%) rural and 462 (49%) urban nursing staff responses. Initial analysis of survey data showed no statistical differences between rural and urban respondents. Therefore, all results presented represent the combined data sets. As with most surveys, response rates to individual questions was not 100%.

The survey divided responders into three age groups: 18-25 year olds (11.5%), 26-55 year olds (80%), and over 55 years old (8.5%). The majority of nursing staff were female (93.5%) (Figure 2). It should be noted that the survey instrument provided options for reporting ethnicity as Caucasian, African American, Hispanic, Native American, and Asian. However, due to the demographic makeup of Mississippi, the number of individuals responding as Asian, Hispanic or Native American was very small and these groups were added to the totals for Caucasians. A total of 25% of nursing staff identified themselves in this group. African Americans constituted the majority of staff, 74.9%. (Figure 2).

The largest group of employees in nursing homes has an entry education level equivalent to a high school degree and some additional training at the certificate level. The education levels were divided into 4 categories: high school/high school graduate (20.3%), certified nursing assistant (CNA; 47%), licensed practical nurse (LPN; 23.3%), or registered nurse with a Bachelor's degree/Registry Exam (RN; 9.5%) (Figure 2). Job titles were based on educational levels: high school/high school graduate education, nursing specific training (including CNA, LPN or RN education), and administrators. The majority of nursing home staff holds a job title requiring CNAs, LPNs and RNs training (85%). The nursing aids category constituted 14.2% of staff (Figure 2). Lecture time dedicated to oral care in a formal training setting was reported by 85.8% of nursing staff with CNA, LPN and RN credentials (Figure 2).

The nursing home staff was surveyed on how much in service training they received in the nursing home where they worked. Most staff (70.6%) reported in service training 1 to 2 times a year. The remaining (29.4%) had received no in-service training at all or training at intervals of longer than 2 years (Figure 2). The question of "hands on experience" concerning the oral care during formal education was also addressed. Most staff reported some hands on experience during training 81.3% (Figure 2).

The survey also asked nursing staff about their own personal dental visits (Figure 2). The responses were divided into three categories: never any dental visits (2.1%), only if in some to severe pain (48.5%), and regular check-ups once a year or more (49.4%).

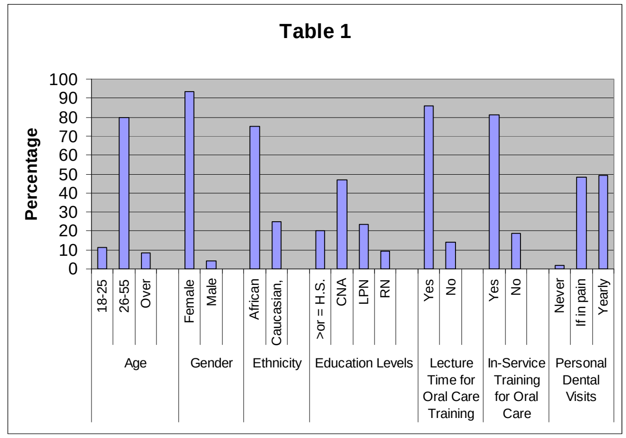


Figure 2. Nursing Staff Demographics. The percentage of respondents are shown for age of staff, gender, ethnicity (Caucasian includes Asian, Hispanic, and Native American), educational levels, lectures for oral care provided as part of training, in-service training for oral care, and personal dental visits.

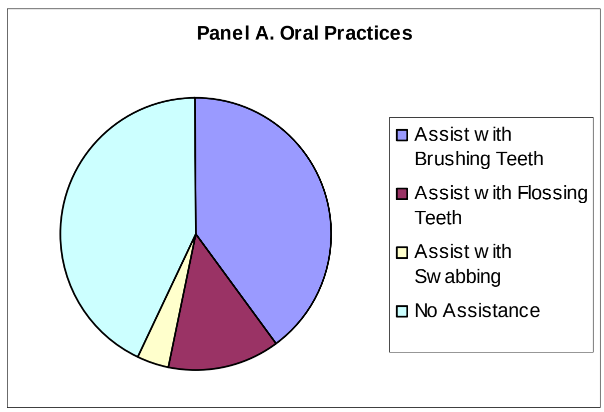
Oral Care Practice in Nursing Homes. A series of questions included in the survey instrument were employed to determine the amount and type of oral care provided to the residents in nursing homes by the staff (Figure 3). Staff reported that 40% of residents required help from the nursing staff to brush their teeth (Panel A, Figure 3). The second component of routine oral care is flossing of the teeth. There was a sharp decrease in the number of patients receiving assistance with this task: nursing staff assisted only 13% of residents with flossing (Panel A, Figure 3), about one-third of those who reported assisting with brushing. An additional question concerning flossing specifically addressed daily flossing, for which the staff reported that 19% of the residents received daily flossing assistance. Interestingly, 64 % of nursing staff reported sufficient time available to provide both these procedures, in sharp contrast to other studies which cited time as a factor in failure to provide these services (12). In our study, the available personnel was not a limiting factor. Sixty-nine% of nursing staff reported that there was adequate personnel to provide oral care in contrast to the Wardh study (12).

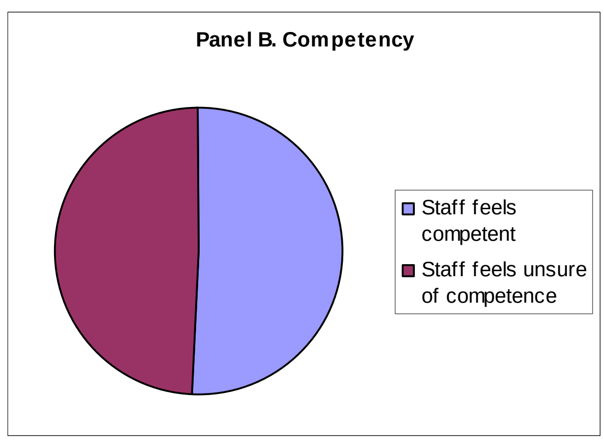
Several adjunct or alternatives to brushing and flossing include the use of rinses, swabs, or denture care. A daily fluoride mouth rinse is recommended to protect roots exposed at the gingival interface and many mouth rinses contain an antimicrobial activity to control infection. Forty nine percent of nursing home staff reported daily fluoride rinse use. The percentage of this group using a combination of fluoride/antimicrobial rinse was not determined. The use of any mouth rinse was reported for residents 63.5% of the time by nursing staff. The use of oral swabs is the most appropriate alternative for brushing, flossing or rinses. The nursing staff reported providing oral swabbing for 4% of the residents (Panel A, Figure 3). Daily denture care was reported by 85% of nursing staff, by far the most common form of oral care assistance provided.

Attitudes of Nursing Staff toward Oral Care. The attitudes of nursing staff toward their role in oral care depend in large part on their personal oral care and the perception of its importance to their patients. Generally, staff reported that 60.8 % of residents requiring assistance were receptive to oral care. A second factor in the attitude of staff regarding oral care is the level of confidence a staff member feels in providing such service. Nursing staff self reported (51%) feeling competent when providing oral care (Panel B, Figure 3). Thus, 49.5% of staff never felt able or were unsure of their ability to assist patients with routine daily oral hygiene practices. Furthermore, 35% of caregivers felt that special oral skills and training were needed to improve their confidence in providing oral care. Indeed, the majority of staff (80%) reported that oral hygiene is equally as important as other duties.

Knowledge of Oral Care. As a baseline assessment, the survey asked the respondents about their perceived level of knowledge about oral care. The majority of staff (84%) self reported good to excellent knowledge of oral care (Panel C, Figure 3). However, following a series of questions concerning standards of care and dental health, a much different picture emerges. Specifically, questions about standards of practice, dental plaque, dentures, oral cancer, periodontal disease, medications, and systemic health as related to dentition were included in the survey. Overall, nursing staff correctly answered only 63% of these objective questions, which is much lower than their self reported excellent knowledge (Panel C, Figure 3).

The correct daily hygiene regimen suggested by ADA was identified by only 68% of nursing staff respondents. The characterization of dental plaque as a biofilm which may contribute to decay and systemic disease was reported by 85% of staff. Overall, 77% of staff had appropriate knowledge of denture care. Few nursing staff (31%) recognized the association of signs and symptoms of oral cancer such as bleeding of the gums or white patches in the mouth or risk factors such as smoking, dentures, and age. The category of periodontal disease was reported correctly by 58% of nursing staff, recognized by bleeding of the gums, loose teeth, and diabetes as common phenomenon of this disease. The extensive use of medications by residents in nursing homes may also play a role in conditions of the mouth, including dry mouth, increased dental caries, ability to eat/drink/swallow, and speak. The majority of nursing staff (62%) perceived medications as potential mediators of these symptoms. Further, the correlation of poor dental hygiene and systemic diseases or diabetes was recognized by 68% of the respondents.





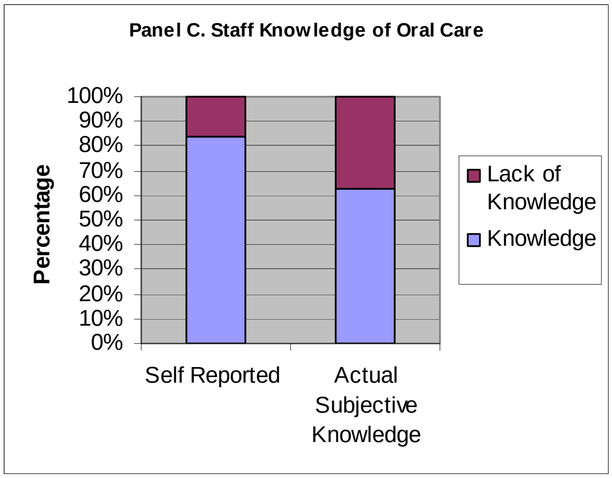


Figure 3. Practices, Attitudes, and Knowledge of Oral Care. Results are presented as percentage of responses by 945 nursing home staff personnel. In Panel A, staff responded to questions regarding daily oral care practices provided to residents requiring such assistance. As shown in Panel B, nursing staff self reported their personal level of confidence in providing oral care. Panel C shows the self reported level of knowledge about oral care as compared to responses on subjective questions requiring specific knowledge about oral health.

DISCUSSION

Clearly, Mississippi has unique problems associated with poverty, lack of education, and the overall health of its population. Although some areas of the state met the definition of urban, we found no differences between nursing staff of urban and rural facilities. In this study, we found the vast majority of nursing staffs were African American. The number of African Americans in this population was almost twice what would have been expected based on the general population of the state (74.9% vs 37.2%). Indeed, Hispanic and Asian populations are underrepresented in both Mississippi's general population compared to national trends and even more so in staffs of our nursing homes, where their numbers were in single digits.

In terms of educational level, the population surveyed had a higher level of education than the general population of the state due to the requirements for employment in this field. These employees generally receive compensation at levels above minimum wage, commensurate with their education above a high school degree. Thus, employment in nursing facilities may represent some of the more desirable positions for individuals who have received specialized training such as that required for CNAs, LPNs, and RNs. Nationally, only 6% of nursing home staffs (25) were RNs; in Mississippi, RNs account for 9.5%.

The issue of dental care in nursing homes is often neglected. Typically, no dental professional is retained by any nursing home in a full time capacity (26, 27, 28, 29, 30, 31, 32). Personal attitudes and beliefs concerning the importance of oral care have been shown to be predictive of not only self-care but use of dental services in general (33, 34,35). Individuals who report negative attitudes toward dental health professionals and dental care were more likely to have tooth loss than individuals with a positive attitude (32). In our study, only 49.4% of nursing staff sought routine annual dental care compared to 59.4% of Mississippians state wide and 71.3% nationally. Other studies have also shown that race and poverty contribute to negative attitudes toward dental care and dental health as well as lack of knowledge of dental services (36).

Regardless of personal attitudes about oral care, the majority of nursing staff reported feeling competent to provide dental care services for patients. Indeed, 86% of staff felt that they had good to excellent knowledge of oral care. Only 37% of nursing staff felt it necessary to have special training to acquire skills pertinent to oral care. Over 80% of nursing staff reported that oral care services were as important as any other duty. Further, they reported adequate time for such duties and the support of the administrative staff.

By law, nursing homes in the United States are mandated to meet the routine and emergency dental needs of nursing home residents (6). This includes oral exams, cancer screening, tooth brushing three times a day, partial and denture cleaning and daily tooth flossing. Nursing staff reported providing less than 50% of patients with brushing and less than 15% with flossing. It is important to note that none of the nursing facilities included in this study had an on-call/on-staff dental hygienist or dental health care professional. Therefore, any screening or routine care would have to be provided by nursing staff, principally nurses' aides.

These staff members would need to have a high level of knowledge of dental health. Cognitively, nursing staff self reported adequate (52%) practice of standards of oral care (brushing, flossing, and fluoride rinses). Indeed, of these, the staff responded correctly to queries concerning this basic level of knowledge (63%). Denture care was specifically addressed by 4 of the 14 standards questions. Nursing staff had much higher levels of knowledge and appreciation for denture care (approximately 78%) than for dental hygiene of dentate patients. Less than 65% of nursing staff respondents correctly noted the importance of daily brushing in dentate patients with even fewer (less than 31%) noting flossing as a daily requirement.

While it is not possible to determine the amount of emphasis in an in-service training session, it is clear that staff have incorporated more information concerning denture care than care for dentate patient oral hygiene. Further, manuals provided to nurses' aides clearly placed priority on denture care. Therefore, an important question to be addressed in any future study would concern emphasis on education about dentate patients and their long term needs. Certainly, a lack of appropriate care in these nursing home patients will result in an increasing number of edentulous patients.

CONCLUSIONS

Mississippi is largely rural and is one of the poorest, least educated, and least healthy states. Although some areas of the state technically qualify as urban, there were no significant differences between urban and rural respondents in the survey, indicative of a homogenous population. Even though the nursing staff population had higher levels of education than the state's general population, the majority still had only high school degrees and/or some specialty training. In the context of the state demographics, they represent a more educated workforce than the general population. Even though the staff reported adequate time, personnel, and administrative support, the level of knowledge and degree to which the staff translated that knowledge into practice of oral hygiene was self reported as inadequate. Specifically, the amount of time spent by nursing staff in Mississippi has been reported at 2.86 hours per resident day (HPRD), well above the national median of 2.32 HPRD but below the recommended 3.0 HPRD by the Centers for Medicare and Medicaid Services (25). Further, nursing staffs are ill prepared in both didactic and practical dental application for the care of nursing residents. Given the potential boom in the nursing home population, the majority of whom will retain some or all of their natural dentition, there is a pressing need to establish national training and educational standards for dental care for the nursing home staff.

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A Review Of Native Vegetation Types In The Black Belt Of Mississippi And Alabama, With Suggested Relationships To The Catenas Of Soil Series

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ABSTRACT

A review of historical information and scientific literature concerning vegetation of the Black Belt region, in Mississippi and Alabama, is used to generate a hypothetical framework of ecological gradients. Remnants of native grassland are well known, but the original pattern of grassland versus woodland appears to have had a complex relationship with soil and disturbance regime. This paper approaches the problem by first displaying variation among soil series along two generalized catenas: (1) from alluvial lowlands, to chalky slopes, to more acid uplands; (2) from relatively mesic well-drained soils, usually more sloping and often relatively shallow (above parent material), to more poorly drained soils, including xerohydric vertisols that often erode down to seasonally xeric subsoils. Fifteen types of native vegetation are outlined, with brief descriptions based on diverse sources. These types are overlaid on the diagram of soil catenas, showing the most characteristic vegetation that appears to have existed in different sections. The result provides a useful initial model for the gradient from lowland to upland vegetation (1). However, variation of disturbance regime in space and time has probably limited the consistency of associations between vegetation and the drainage-related gradient (2). Deeper woods are concentrated on more mesic sites, and became increasingly restricted when human influence spread over the landscape. Grasslands may have originally occurred on a wide range of chalky, clayey or sandy soils, from hydric to xeric, but became greatly modified after European settlement.

INTRODUCTION

The Black Belt in Mississippi and Alabama is readily defined in terms of its calcareous geology and chalky soils, together with its largely agricultural modern land uses (USFS 2007). Several authors have provided useful studies of this region's vegetation: Hilgard (1860), Mohr (1901), Lowe (1911, 1920), Harper (1913a, 1920, 1943), Myers (1948), Rostlund (1957), Jones and Patton (1966), Rankin and Davis (1971), DeSelm and Murdoch (1993), Brown (2003), Barone (2005a), Barone and Hill (2007), Schotz and Barbour (2009), and others. However, details of the original vegetation have remained somewhat obscure, since so much of the land became agricultural early after colonization. Cotton became dominant economically during the 19th Century, but was partly replaced in the 20th Century by soybeans and corn, especially on lowlands, and by forage and pasture, especially on uplands (Cleland 1920, Wiygul et al. 2003).

The purpose of this paper is to outline the varied native vegetation types within the Black Belt, based on available historical and scientific literature. Given the apparent importance of soil in controlling patterns of vegetation, an effort is made to express the fundamental "catenas" in geological and topographic gradients among soil series, as defined by the US Department of Agriculture. Based on the literature, typical original vegetation is then suggested for each section of the gradients in soils. The paper does not present a definitive analysis, but builds a hypothetical scheme of relationships to be tested with more systematically collected data in the future.

This review was prompted by field work during 2009 at the Pulliam Prairie in Chickasaw County, Mississippi (Campbell & Seymour 2011b, 2011c). Although initial hypotheses were developed mostly at that site, the context here has been extended to the whole Black Belt region. Moreover, similar soils and vegetation occur in other "blacklands" on the Gulf Coastal Plain, from Texas to Georgia (NatureServe 2010). Outside the strictly defined Black Belt on Cretaceous chalks, there are some calcareous soils with remnants of native grassland on Paleocene or lower Eocene parent material, from Tennessee (D. Estes, pers. comm.) to Georgia (Echols 2007, Echols and Zomlefer 2010). Further south, the

Jackson Prairie region of Mississippi and Alabama lies on calcareous clays of upper Eocene age, and has much similarity to the Black Belt (Moran et al. 1997, Barone 2005b, Barone and Hill 2007). Although this paper is focused on the Black Belt, it does make some reference to similar vegetation in those other regions (as local 'associations' or 'floristic vicariants'), in order to advance more functional descriptions of broader types that might be applied to blacklands in general (as 'alliances' or 'ecological classes').

OCCURRENCE OF NATIVE GRASSLAND

Barone and Hill (2007) have recently conducted a broad floristic survey of native grassland remnants in the Black Belt and Jackson Prairie regions. The concentration of several conservative or rare grassland plant species in the Black Belt suggests that grassland has existed here for much of the post-glacial era and before. There is also increasing evidence that several populations of animals found in the region are—or were—disjunct from more extensive populations in the Great Plains. These animals include extant insects (e.g., Brown 2003, Hill 2007, Hill and Brown 2010) and extinct horses (Kaye 1974).

However, there has been some controversy about the degree of openness, which may have varied greatly in association with patterns in soils and in the frequency of burning by native people. If the region is broadly defined to include river valleys with alluvial soils, and intermixed ridges with more acid soils, it is estimated that about 10-35% of this whole landscape was truly open grassland or savanna with no more than 10 trees per acre (Harper 1913b, Cleland 1920, Jones and Patton 1966, Rankin and Davis 1971, Barone 2005a). But these openings were concentrated on about 70-75% of the more calcareous uplands where typical soil pH is about 6.5-8.5. Much other land across the whole region probably had woods with some degree of opening caused by fires or other disturbances, and about 10-40% appears to have been completely closed forest. Before European settlement, adjacent regions generally appear to have had less grassland than the Black Belt, but the woods in some of these regions were probably much influenced by fire (Rostlund 1957, Brewer 2001, Peacock et al. 2008).

When Europeans first entered the Black Belt in 1540, there were significant concentrations of native people, who provided the first serious resistance to De Soto's expedition in North America (Clayton et al. 1993). During 1500-1760, the Alabama and other tribes were based in central Alabama, numbering several thousand (Hook 1997; see also, www.ac-tribe.com/ac). The Choctaw were centered in western Alabama and east-central Mississippi, with several villages in the Black Belt, as described in accounts cited by Rostlund (1957). Further north, the Chickasaw tribe was centered in northwestern Alabama, northeastern Mississippi, western Tennessee, and southwestern Kentucky, numbering about 10,000-15,000 (Nairne 1708, Morgan 1996, Sultzman 1999, Johnson 2000, O'Brien 2003). In Mississippi, there was a relatively dense concentration of people along the Tombigbee River and its tributaries from near Columbus to Tupelo. Many villages existed in this region, usually on the low bluffs ('cuestas') along the western or southwestern side of these streams, often adjacent to openings on the chalky slopes and overlooking lowland plains with the most productive fields (B. Lieb, personal communication from The Chickasaw Nation; Peacock and Miller 1990). The land of the Chickasaw was even "better provided with these plains than the Choctaw country, the landscape more beautiful, and the soil better" (Anonomous source, ca 1755; cited by Rostlund 1957).

As described by Nairne (1708) and other early authors (see above), these native people used much lowland to grow corn and other crops, including nuts and fruits from various trees and shrubs. Based on Rostlund's (1957) review, it is likely that some of these lower open areas—often described as "fields" or "savannas"—were burned on a rotation. His historical sources also suggest that native people burned adjacent uplands in the region, as well, in order to increase production of game and other wild food. Burning may well have caused grassy openings to spread up from the thinner chalky soils. Bison were hunted in the Black Belt region about the time of European conquest, and may have increased in numbers when native human populations declined (Johnson et al. 1994).

After Spanish invasion, subsequent colonization and removal of the tribes, the Black Belt became increasingly used for intensive farming, with cotton becoming the major exported 'cash-crop' (Cleland 1920, Gibson 1941). Burning of native vegetation became greatly reduced. Good stable remnants of native grassland—or grassy open woodland—became virtually restricted to a few upland areas with relatively shallow, erodible or otherwise unproductive soils.

GEOLOGY, TOPOGRAPHY AND SOILS

The Black Belt is largely underlain by Upper Cretaceous sediments that are generally known as the Selma Group, of which the Demopolis Chalk is predominant. The Demopolis is composed of "chalk and marly chalk containing fewer impurities than underlying and overlying formations" (Moore 1985). [Chalk is limestone of calcite, i.e. $CaCO_3$ deposited by unicellular haplophyte algae; marl is mudstone of clay and much aragonite, i.e. $CaCO_3$ deposited by molluscs, corals and other animals.] Overlying the Demopolis Chalk are varied sediments of the Cretaceous-Tertiary transition, which are either included in the Selma Group or segregated as the Midway Group. This transition includes the Ripley Formation, which forms the Pontotoc Ridge—a more sandy physiographic strip along the western side of the Black Belt in Mississippi. The Ripley is composed of "gray to greenish-grey fine glauconitic sand, clay and sandy limestone" (Moore 1985). [Glauconite is iron silicate plus minor amounts of other minerals.] Underlying the Demopolis Chalk is the Mooreville Chalk of the Selma Group, and below that is the Eutaw Formation, which is a glauconitic sandstone of the Tuscaloosa Group.

The USDA (2010a,b) has provided detailed descriptions of soil series, regional maps and maps for each county. Relationships of soil series to topography and geology are often summarized with diagrams in the published soil surveys. From a detailed review of this material, it is possible to construct a two-dimensional diagram that displays 'catenas' of soils (i.e., sequences along gradients that sort out attributes) among typical series reported from the Black Belt (Fig. 1). This diagram was arrived at through successive approximation, the organizing goal being to place the most similar soil series closest to each other; for an earlier application of the method, see Campbell and Grubbs (1992). Overall similarity was judged subjectively based on parent material, texture, landscape position, slope, depth, drainage, acidity, and color (see Supplementary Material for overlays of individual attributes).

The vertical dimension in Fig. 1 displays the elevation-related gradient, from alluvial lowlands, to the chalky soils on gentle side slopes, to the overlying clays and sands on broader ridges. The horizontal dimension displays the drainage-related gradient, from well drained slopes with generally shallower soils above parent material (left), to poorly drained flats with generally deeper soils (right). Some of the poorly drained soils have 'xerohydric' character, with great fluctuations in water table through the seasons. For example, the Trebloc soil series, on upland flats (at upper right in Fig. 1), is known to experience particularly wide fluctuations (Pettry et al. 1995).

Soil series on chalk are mostly classed as various vertisols (Fig. 1)—with expansive 'shrink-swell' clays (Pettry and Switzer 1993), and 'self-mulching' of organic matter into deep A horizons. Similar vertisols (as chromic hapluderts) have been detailed in the Jackson Prairie by Moran et al. (1997). More local soil classes include entisols (especially on more recent colluvium/alluvium), inceptisols (especially on deep/damp colluvium/alluvium), mollisols (often with more stable grass, cane or cedar cover), and alfisols (on more weathered loamy uplands with more woodland history just above the chalk). In contrast, loamy ultisols (with generally less base saturation) predominate above the chalky soils, on more sandy uplands or on high terraces, usually with a history of more woodland than grassland.

Uplands in the Black Belt, as in some other blacklands (e.g. Moran et al. 1997), are prone to severe sheet and gully erosion, even on gentle slopes. Natural erosion is already a widespread feature of chalky soils in the region, but land clearance and farming have caused substantial increases. The valley floor of Sakatonchee Creek in Chickasaw County, Mississippi, appears to have risen by 10-20 feet within the past century, based on observations at bridges (S. Pulliam, pers. comm.). Similar observations have been made across north-central Mississippi (Grissenger et al. 1982). Adair (1775; p. 358, 413), Harper (1913a), Gibson (1941) and several other early geographers pointed out that erosion often exceeds weathering on uplands in the Black Belt, leaving a thin layer of clayey soil or disintegrating chalk—or 'rotten limestone'—above more consolidated parent material. However, erosion appears to be retarded where there are remnants of thicker acid clays on ridges, often associated with post oak and other trees.

ULTISOLS	ALFISOLS	VERTISOLS	MOLLISOLS	INCEPTISOLS	ENTISOLS

TYPICAL PARENT MATERIAL	**TYPICAL TOPOGRAPHY**				
	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil	TRANSITIONAL	INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep	TRANSITIONAL	LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		Typic KANDIUDULT Faceville fine sandy loam	Glossic FRAGIUDULT Prentiss loam	Fluvaquentic PALEUDULT Brewton fine sandy loam	Typic PALEAQUULT Trebloc silt loam
Sandy uplands or high terraces: sandy loams to fine sandy loams		Typic FRAGIUDULT Ora sandy loam	Typic FRAGIUDULT Savannah fine sandy loam	Fluvaquentic PALEUDULT Stough fine sandy loam	Note: Brewton is close to Stough but with more eluviated clay
Clayey uplands: acid clay and locally sand or silt above calcareous	Ultic HAPLUDALF Brantley fine sandy loam	Vertic PALEUDALF Boswell fine sandy loam	Vertic PALEUDALF Kipling silt loam	Aquic HAPLUDERT Brooksville silty clay loam	Chromic DYSTRAQUEPT Eutaw silty clay
Clayey uplands: more influence of acid clay than chalk; not loamy	Note: Boswell and Brantley are mostly mapped on Paleocene/Eocene	Leptic HAPLUDERT Watsonia clay	Chromic DYSTRUDERT Oktibbeha clay	Aquic DYSTRUDERT Vaiden clay	Note: "Houston" included fine sandy loams on Paleocene (Harper 1920)
Chalky uplands: gentle slopes with influence of overlying clay		Oxyaquic HAPLUDERT Maytag silty clay	Oxyaquic HAPLUDERT Okolona silty clay	Oxyaquic HAPLUDERT Houston clay	Note: "Houston" has often eroded down to Sumter (Gibson 1941)
Chalky uplands: steeper side-slopes to local alluvial flats with clay	Typic HAPRENDOLL Binnsville silty clay	Rendollic EUTRUDEPT Sumter silty clay	Aquic HAPLUDERT Griffith silty clay	Chromic EPIAQUERT Sucarnochee silty clay	
Chalky uplands: loamy toe-slopes, swales and alluvial transitions	Note: mesic soils on NE-facing bluffs with sugar maple need definition here	Typic UDORTHENT Demopolis silty clay loam	Aquic HAPLUDERT Faunsdale clay loam	Vertic EPIAQUEPT Leeper silty clay loam	
Floodplains: loamy alluvium along perennial streams			Fluvaquentic HAPLUDERT Marietta loam	Aeric FLUVAQUENT Belden silty clay loam	Note: more open marshy wetland soils need definition here
Floodplains: deep clayey alluv. along streams and backwater sloughs		Typic HAPLUDERT Trinity clay	Fluvaquentic HAPLUDOLL Catalpa silty clay loam	Vertic EPIAQUEPT Tuscumbia silty clay loam	Typic EPIAQUEPT Una silty clay

Figure 1. Diagram showing generalized catenas of soil series in the Black Belt region, as related to parent material and topography. Within each box: 1st line = soil group modifier; 2nd line = soil group/class (upper case); 3rd line = series name; 4th line = typical texture. See USDA (2010a) for detailed descriptions of each soil series. Soil orders are color-coded as shown in the lower bar. Some common soils in peripheral sections of the Black Belt are included here, but soils more typical of disjunct blacklands elsewhere in southeastern states are excluded (e.g. Hannon, Okeelala and Toxey). [Supplementary material with details of trends in edaphic data is available from the senior author.]

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NATIVE VEGETATION TYPES Based on available literature, the following vegetation types can be broadly defined, with potential segregates indicated in several cases. These types are ordered here with an informal letter code—(a) to (o)—that is used for cross-reference to an accompanying paper (Campbell and Seymour 2011b). Numbers in parentheses after "NVC" refer to the "CEGL" codes for the most similar vegetation types in the National Vegetation Classification of NatureServe (2010).

Botanical nomenclature primarily follows the list of vascular flora in Mississippi that is being developed at the Pullen Herbarium in Oxford (McCook and Kartesz 2010), based initially on Kartesz (1999).

Uplands with Acid Soils Overlying Calcareous Sediments. These diverse soils have varied components of clay, silt or sand, occuring on uplands within the Black Belt and in transitions to the Pontotoc Ridge or other adjacent uplands. Subsoils have red, brown, yellow or gray hues.

(a) Oak woods on ridges and knolls (NVC 7246, 2075). Several observers have indicated the historical place of such woods in the landscape. In addition to the locally wet "flatwoods" with much post oak that were extensive just outside the western and southern borders of the Black Belt (Mohr 1901, Lowe 1921), there were more fragmented oak woods on uplands scattered within much of the region. For example, in the northern Black Belt, Nairne (1708, p. 36-39) described traveling "up and down the savannas... among a tuft of oaks on a rising knowll, in the midst of a large grassy plain." M. McGee (1841, p. 60 in Atkinson, 2004) recalled "Old Fields" ca. 1750-70 in the Tupelo area, from "Old Town" towards "Long Town" and "Post Oak Town"—these fields were "some 13 or 14 miles long by about 4 broad, with here & there a copse of wood to dot the wide & long extended expanse." In the western transition, Ward (1987) used details of the 1834 survey to map islands of post oak within the prairie, just above sites of human occupation. Hilgard (1860) provided several notes of such oak woods, and Harper (1913a) generally noted "oak groves on broad low knolls of poorer soils."

There has been little botanical description of these oak woods. In Mississippi, Lowe (1921) noted: "On the lighter and usually higher [yellowish-brown to] reddish soil areas which dot the prairie surface like islands, an entirely different assemblage occurs. The soil is not so rich in plant food as the black soils, lime especially being in much smaller proportions. These areas support a rather dwarfish growth of a few species of trees, chiefly oaks, the commonest being..." [with modern names] chiefly *Quercus stellata, Q. marilandica* and *Q. falcata*; also present, *Q. velutina, Q. durandii* Buckl. (= *Q. sinuata* auct.), *Carya tomentosa, Diospyros virginiana, Pinus echinata, Prunus serotina* and *Rosa carolina*. He noted more distinct flora in the red sandy hills that intermix with the Black Belt, on soils typical of the Pontotoc Ridge and plains further west, adding *Liquidambar stryraciflua, Sassafras albidum, Rhus* spp., *Vaccinium arboreum* and *Vitis rotundifolia*.

In Alabama, Bartram's (1791) early account of the "expansive illuminated plains" south of Montgomery is insightful: "They are invested by high forests, extensive points or promontories, which project into the plains on each side, dividing them into many vast fields opening on either side as we passed along." Hawkins (1798-99) also described these plains: "They are waving, hill and dale, and appear divided into fields. In the fields the grass is short, no brush; the soil in places is a lead color, yellow underneath, and very stiff [suggesting the dystrudert series, Vaiden, in Fig. 1]. In the wooded parts the growth is generally post oak, and very large, without any underbrush, beautifully set in clumps. Here the soil is dark clay, covered with long grass and weeds, which indicates a rich soil..." [suggesting the more alfic Brooksville or Kipling soil series]. Mohr (1901) and earlier authors (Romans 1775, Darby 1818; W. Roberts 1818, quoted in Rostlund, 1957) described oak woods in Alabama similar to Lowe's (1921), adding other species of *Carya* (*glabra*, ?*ovata*), dogwood (*Cornus florida*), ironwood (?*Ostrya*) and, locally, poplar (*Liriodendron*) to the list of typical trees. Mohr also detailed the poorly drained condition in some areas, with distinctive grasses, diverse sedges and allies in *Carex, Cyperus, Eleocharis* and *Scleria*; the latter appears to have been locally abundant in drier transitions. On drier ground, legumes were relatively common: *Desmodium* spp., *Lespedeza* spp., and "Japanese clover" [*Kummerovia striata*].

Today, post oak is generally dominant in older woods on uplands, and large open-grown post oaks are frequently left around old home sites for shade, or along old surveyed boundaries. Hill et al. (2009) surveyed a hectare of woods adjacent to the Osborn Prairie in Oktibbeha County, Mississippi. These woods were dominated by post oak and red cedar (*Juniperus virginiana*), plus scattered loblolly pines ca. 30-60 years old. Other trees included oaks (*Quercus*: *marilandica, durandii, falcata, velutina, alba*), hickories (*Carya*: *ovata, myristicaeformis, tomentosa*), white ash (*Fraxinus americana*) and winged elm (*Ulmus alata*). Ground vegetation contained common shade tolerant species, with none characteristic of grassland.

(b) More open woods with local blackjack oak (b1) or shortleaf pine (b2), plus associated thickets and glades (NVC 4053, 3952—or 4670 on more calcareous soils). As emphasized by Rostlund (1957)—but perhaps overemphasized—before the 1830s, there are indications of open woods with grassy conditions at many localities in regions with acid soils adjacent to, or intermixed with, the Black Belt grasslands on chalk. He suggested that frequent fires were involved in maintaining these areas, and that the Black Belt itself was not much more open.

On plains west of the Black Belt in Mississippi, a regional increase in pine began about 2400 years ago, which is attributable to promotion of fires by people (Whitehead and Sheehan 1985). Based on early surveys, fire-tolerant oaks and pines were generally more abundant in upland woods of north-central Mississippi during the 1830s than they are in woods today, but patterns varied much in space and time (Brewer 2001, Peacock et al. 2008, Surrette et al. 2008). The pyrophile, blackjack oak (*Quercus marilandica*—probably including much "black oak"), was locally dominant then, but it has now greatly declined. Pines—shortleaf (*Pinus echinata*) or loblolly (*P. taeda*)—were more frequent than blackjack oak locally, especially on lower slopes with more sandy soils, where fire regimes may have been somewhat less intense or less frequent. Today, shortleaf pine remains one of the most common trees in mature woods on drier sites of north-central Mississippi, but white oak (*Q. alba*) predominates on more mesic uplands, often with much southern red oak (*Q. falcata*) and hickories. Also, the highly fire-sensitive sweetgum (*Liquidambar*) has generally increased, spreading from lowlands onto uplands.

Within the Black Belt, we have few historical details of patterns in the degree of openness, but blackjack oak appears to have been locally abundant, at least in Mississippi. A relevant note on the Tupelo area comes from Nutt (1805; p. 43 in Jennings, 1947): "The country around Big Town for many miles affords good farming land. Many prairies, no running water near the town... [But] The country between Big Town & ... 20 mile creek [main branch of Tombigbee to the east]... is poor broken black-jack land. No running water. On the creek is fine cane, the bottom subject to overflow in spring season... the branches of this creek interlock with the head of Tal,la,hat,chee [of Yazoo River to the west, and] is high broken land very little fit for cultivation." From Pontotoc to Chickasaw County, Hilgard (1860, p. 91 and 100) noted "ridges characterized by an excessively heavy soil, bearing the Black Jack Oak, and popularly termed "beeswax hommocks"...[on] gray calcareous clay which frequently overlies the limestone and calcareous sand" [perhaps matching the hapludert, Houston, in Fig. 1].

Pines were virtually absent within the Black Belt of Mississippi before modern planting programs, which concentrated on loblolly pine. Shortleaf pine was locally frequent only on the more acid soils in adjacent western regions, including Pontotoc Ridge and the Post-oak Flatwoods (Harper 1913a, Brewer 2001, Peacock et al. 2008, Surrette et al. 2008). But in Alabama, pines—mostly shortleaf—formed ca. 5-9% of witness trees across the whole Black Belt in 1830-50 (Jones and Patton 1966, Rankin and Davis 1971). Especially in the relatively hilly sections of eastern Alabama, there is more intermixing of geological and topographic features, and marly soils predominate rather than pure chalk. This mix was reflected in a more intimate combination of shortleaf pine or other pines with hardwoods typical of the Black Belt (Mohr 1901, Harper 1913b). Some remnants of grassland in Alabama today are surrounded by pine-oak woods (Schuster and McDaniel 1973, Schotz and Barbour 2009).

(c) Upland prairies on somewhat acid soils; (c1) xeric-tending or (c2) locally xerohydric (with potential affinity to NVC 2242, 2405 and 5057). It is likely that the chalk prairies often graded into less calcareous grassland on adjacent uplands. Extensive prairies on relatively acid soils were not well documented in early botanical literature. But, traveling south across Pontotoc County into the Black Belt of Mississippi, Hilgard (1860, p. 79-81) noted: "...on the Connewar, Chiwapa and Tallabinella [Creeks], the regular prairies set in, with their 6 to 10 foot stratum of yellow clay overlying the Rotten Limestone"; see also the quotation from Hawkins under (a) above. Hilgard noted that these "larger bodies of prairie" extended east from the

“Orange Sand” at the base of the Ripley Formation to cover the broad “dividing plateau” of major streams within the Black Belt, including the “Mayhew Prairie” below Palo Alto. They were interspersed with “greatly inferior” soils on residual uplands, presumably including more sandy ultisiols (as in upper rows of Fig. 1). His description of the “12 to 18 inches” of “black prairie soil” above (2) 5-7 (10) feet of “pale yellow clay containing small round ferruginous concretions” suggests dystrudert soils such as the series Oktibbeha and Vaiden (Fig. 1). He contrasted this general upland prairie with the “small prairies” or “bald prairie spots” at lower stratigraphic levels where chalk was much closer to the surface, especially “on the [eastern] outskirts, in these wooded portions, and on the streams, not in the prairie proper.”

More open oak woods and edges on transitional uplands do contain diverse sun-loving species that could have been promoted by fires before De Soto, as well as by xeric or xerohydric conditions at some sites. In Mississippi, Lowe (1921) listed the following sun-loving plants as characteristic of more acid uplands around the Black Belt [converted here to modern names]: *Apocynum cannabinum, Ceanothus americanus, Gamochaeta purpurea, Krigia virginica, Oenothera* sp., *Orebexilum* sp., *Opuntia* sp., *Penstemon laevigatus, Phlox pilosa, Plantago aristata, Schrankia microphylla, Stylosanthes biflora, Tephrosia virginiana, Triodanis perfoliata,* and *Verbena* sp. S. Brewer (personal communication) is currently investigating the extent to which suppressed populations of sun-loving plants, in general, can be increased with fire in seasonally dry woodlands of north-central Mississippi. He has found strong reponses by several legumes (Fabaceae), *Dichanthelium* spp. (Poaceae), and, especially in thinned woods, *Helianthus* spp. and allies (in Asteraceae). Less common potential increasers with fire in this region include *Aletris aurea*, *Aureolaria pectinata*, *Eryngium yuccifolium*, *Eurybia hemispherica*, *Gentiana villosa*, *Gratiola pilosa*, *Helianthus silphioides*, *Liatris squarrulosa*, *Matelea carolinensis*, *Phlox pilosa*, *Piptochaetium avenaceum*, *Polygala cruciata*, *Pogonia ophioglossoides*, *Sabatia campanulata*, *Silphium integrifolium* and *Xyris jupicai* (Denley et al. 2002).

In Alabama, varied accounts suggest that thin woods on uplands have often graded into prairies, which sometimes occurred in small patches or on transitional soils from sandy to calcareous. Gosse (1859, p. 82) reported contemporary usage of the term “forest prairie” for the vegetation he found on a “little knoll” within denser woods. Mohr (1901) described much of the general upland vegetation south of the Black Belt as “post oak prairies”—a term also used around the Jackson Prairies by Hilgard (1860) and others (Moran et al. 1997). Open post oak woods are known today across southeastern states, often with seasonal extremes of wetness and dryness that promote extensive graminoid ground vegetation and some shrubby openings (as in NVC 5057 and 2405). Mohr also noted that “sand hills near Montgomery” had openings with several distinctive xerophile or annual grasses (*Aristida, Eragrostis, Panicum*) and herbs, including *Brickellia eupatorioides*, *Croptilon divaricatum, Mirabilis* sp. (“*hirsuta*”), *Symphyotricum* spp. (“*patens*” and “*undulates*”), and *Tragia urticifolia* (cf. NVC 2242). There were some frequent acidophiles in Harper’s (1920) prairie, e.g. *Polygala grandiflora*, and in the three-acre glade within pine-oak woods studied by Schuster and McDaniel (1973), e.g. *Hypoxis hirsuta* and *Schoenolirion croceum*. In some of the grasslands surveyed by Schotz and Barbour (2009), such as the Cahaba River Prairies, several of the reported common plants are more typical of acid or sandy soils, rather than purely calcareous, e.g., *Agalinis tenuifolia, Aristida virgata, Desmodium marilandicum, Liatris squarrulosa, Physalis carpenteri* and *Sporobolus junceus*.

Uplands with Calcareous Soils. In the National Vegetation Classification (NatureServe 2010), calcareous grassland and associated vegetation on the southeastern Coastal Plain is treated in a few broadly defined alliances that reflect the general gradient from xeric, open conditions to more mesic, shady conditions. However, at moderate scales of ca. 1-10 acres [0.4-4 ha], there is usually much intermixing of the grassland types outlined below (d, e, f and g), which are often partly or completely combined in published descriptions.

(d) Upland prairie on xeric-tending (d1) or locally xerohydric (d2) sites. At dry open extremes on shallow, eroding or disturbed soils, there is mid-sized to short grassland, locally dominated by annuals and usually mixed with patches of bare ground that has relatively little organic matter (Schauwecker 1996). In poorly drained swales, there can be extremes of both wetness and dryness, with particularly unstable and relatively bare soil surfaces. This type of grassland occurs locally in much of the Black Belt on or near outcrops of chalk (Harper 1920, Schuster and McDaniel 1973, Morris et al. 1993, Leidolf and McDaniel 1998), and similar vegetation has been described in other blacklands (e.g., Echols and Zomlefer 2010). NatureServe (2010) has defined a variant of such vegetation from the Cook Mountain Prairie of Louisiana (NVC 4021) that could be extended and applied to much of the Black Belt: *Schizachyrium scoparium*-*Panicum flexile*-*Carex microdonta*. But at the Pulliam Prairie (our personal observations) and at some other sites in the northern Black Belt (C. Bryson, personal communication), *Carex crawei* largely replaces *C. microdonta*.

Other characteristic graminoids in such vegetation include *Aristida* spp. (*longespica*, *oligantha*, *purpurascens*), *Bouteloua curtipendula, Fimbristylis puberula* and *Sporobolus* spp.—*vaginiflorus* (on bare ground), *clandestinus* (in less xeric transitions) or *compositus* (locally on deeper soils). Typical herbs include *Asclepias viridiflora, Coreopsis lanceolata, Croton monanthogynus, Dalea candida, Erigeron strigosus, Euphorbia corollata, Heliotropum tenellum, Heterotheca camporum, Houstonia nigricans, Hypericum sphaerocarpon, Liatris squarrosa, Linum sulcatum, Lithospermum canescens, Lobelia spicata, Mirabilis albida, Penstemon tenuiflorus, Solidago nemoralis, Symphyotrichum patens, Silphium laciniatum* and *Verbena simplex*. The number of vascular species in small plots tends to be relatively low: ca. 5-15 per 0.25 m^2 (Weiher et al. 2004). However, composition varies greatly across larger plots, in relation to local topography, erosional patterns, and broad intergradation with the taller grassland outlined below (types e, f and g).

(e) More disturbed prairie on stressed or eroded sites, often transitional from (d) to (f). Mixing of characteristic species from more xeric sites (type d) and less xeric sites (type f) has probably been enhanced where soils are disturbed by grazing, mowing or plowing. Many remnants today are in various stages of recovery from farming, especially on deeper soils of lower ground that receives or holds more moisture. Several authors have noted that disturbance has led to local abundance of more weedy native species plus more frequent aliens (Mohr 1901, Harper 1913, Harper 1920, Leidolf and McDaniel 1998, Echols and Zomlefer 2010, NatureServe 2010).

Commonly reported grasses in these sources are *Andropogon* spp.—*virginicus* on drier sites (most/all as var. *decipiens*), or "*glomeratus*" on damper sites (most/all as var. *pumilus* = *A. tenuispatheus*). *A. glomeratus* was used by NatureServe in earlier names for some regional variants. Other locally common native grasses that are relatively tolerant of disturbance include *Panicum anceps*, *Muhlenbergia capillaris*, *Paspalum floridanum* and *Setaria parviflora*. Characteristic herbs include relatively weedy natives, such as *Ambrosia* spp., *Cuphea viscosissima*, *Erigeron* spp., *Prunella vulgaris* var. *lanceolata*, *Sabatia angularis*, and *Symphyotrichum pilosum*. Aliens are locally common, including the rather short but rapidly spreading grasses, *Bromus japonicus, Digitaria ischaemum, Paspalum dilatatum* (formerly planted for forage) and *Sporobolus indicus*, as well as taller species that often extend into less frequently stressed or disturbed sites (see f).

(f) Upland prairie on average sites; generally subxeric. This mid-sized to tall grassland appears to have been the most widespread type in blackland prairies of southeastern states. NatureServe (2010) and others have described regional variants from the Black Belt of Tennessee, Mississippi and Alabama (NVC 4664; see also, Schotz and Barbour 2009), the Grand Prairie of Arkansas (NVC 7769), the Jackson Prairie of Mississippi and Alabama (NVC 4020), the Jackson Prairie west of Louisiana (NVC 4721), and the prairies on lower Eocene clays in Alabama (Harper 1920) and Georgia (NVC 4247; see also, Echols and Zomlefer 2010). Among the most widespread and locally abundant species are *Schizachyrium scoparium* (except in Georgia), *Sorghastrum nutans, Panicum virgatum* and *Ratibida pinnata*. Species that are less generally abundant but still typical of better remnants within the Black Belt, include *Dalea* spp. (*candida, purpurea*), *Liatris* spp. (*aspera, spicata, squarrosa*), and *Silphium* spp. (*integrifolium, laciniatum,* *terebinthinaceum*).

Historical sources support this general description of the prevailing grassland on uplands (Bartram 1791, Mohr 1901, Harper 1913a, Lowe 1921). From Harper's transects of the region, he noted: “The comparatively large numbers of herbs, and the occurrence of a few genuine prairie species, such as *Ambrosia bidentata, Silphium laciniatum, S. terebinthicaceum, Mesadenia tuberosa* [= *Cacalia* or *Arnoglossum plantagineum*], and *Polytaenia nuttallii* (the last three seen only once, and therefore not listed), are reminders of the prairie conditions that once existed in this region.” Several early, colorful accounts also indicate that wild strawberries (*Fragaria virginiana*) were locally abundant in the prairie, presumably proliferating after burning, grazing, cropping or other disturbance (e.g., De Montigny 1736, quoted in Rostlund, 1957; Romans 1775, Bartram 1791).

Other typical species can be inferred from Mohr (1901), Lowe (1921), DeSelm and Murdoch (1993), Schauwecker (1996), Leidolf and McDaniel (1998), NatureServe (2010), Schotz and Barbour (2009) and others, though taxonomy remains uncertain in some cases. These include *Agalinis* spp. (*auriculata, oligophylla, purpurea*), *Asclepias* spp. (*tuberosa, viridis, verticillata*), *Blephilia ciliata*, *Buchnera americana*, *Coreopsis* spp. (*lanceolata, grandiflora*), *Desmanthus illinoensis*, *Desmodium* spp. (especially *ciliare*), *Dracopsis amplexicaulis*, *Eupatorium* spp. (*altissimum, serotinum*), *Helianthus* spp. (especially *hirsutus*), *Lythrum alatum* (perhaps all as var. *lanceolatum*), *Neptunia lutea*, *Oenothera* spp. (*biennis, speciosa, triloba*), *Rudbeckia* spp. (*hirta*, *laciniata*, *triloba*), *Sabatia angularis, Sisyrinchium albidum*, *Solidago* spp. (especially *nemoralis*), *Spiranthes magnicamporum*, *Sporobolus compositus* (perhaps all as var. *drummondii*), *Symphyotrichum* spp. (*dumosum, ericoides, patens*), and *Verbena* spp. (*angustifolia*, *canadensis*, ?*hastata*). The number of species in small plots tends to be relatively high: ca. 10-20 in 0.25 m2 (Weiher et al. 2004).

Although there are many small remnants of the original grassland covering ca. 1-10 acre [0.4-4 ha], larger remnants are rare. NatureServe (2010; with reference to NVC 4664) stated: “Nearly all of this association has been destroyed for agricultural uses, or altered by grazing and fire suppression. No high-quality examples are known.” The aliens, Bermuda grass (*Cynodon dactylon*), Johnson grass (*Sorghum halepense*), and sweet clovers (especially *Melilotus alba*), became widely abundant in the region ca. 1850-90, after being introduced for pasture and hay (Gosse 1859, Mohr 1901, Harper 1913a). The highly persistent sericea lespedeza (*L. cuneata*) has been widely sown to build soils on dry or eroded during 1950-1990. Also, fescue (*Festuca arundinacea*) has been widely sown for forage in converted grasslands after 1950, though it does not generally invade more intact remnants of drier native grassland. In recent decades, cogon grass (*Imperata cylindrica*) has become another serious alien threat to this grassland and other types, especially in seasonally damp swales.

(g) More mesic (g1) or hydric (g2) prairie. These variants can include more tall grasses, especially (in g1) big bluestem (*Andropogon gerardii*) and locally (in g2) gamagrass (*Tripsacum dactyloides*). Also, there are more tall herbs—notably *Symphyotricum novae-angliae*—and more marginal wetland species—notably *Lythrum alatum* on “seepy inclusions” (NatureServe 2010; within NVC 4664). Although *A. gerardii* is now rare to absent in most remnants, it was probably much more common in the original vegetation before agricultural conversions, especially where there was frequent burning that reduced woody thickets on lower slopes (Mohr 1901, Leidolf and McDaniel 1998, Hill and Seltzer 2007, Echols and Zomlefer 2010). Even without woody encroachment, Johnson grass (*Sorghum halapense*) and other aggressive aliens can preempt habitat for taller native grassland. In more shady transitions to riparian thickets and woods, there are several characteristic cool-season grasses. Mohr (1901) listed *Elymus* [*glabriflorus, virginicus*], *Bromus* [*pubescens*] and *Chasmanthium* [*latifolium, sessilifolium*] for “sheltered borders” [using suggested modern names instead of his usage]. Sedges and allies (Cyperaceae) are also locally abundant on wetter sites.

Good examples of such vegetation appear to be rare, and almost no sites have been described in detail. In Mississippi, Hill and Seltzer (2007) recently added *Andropogon gerardii* and *Tripsacum dactyloides* to the list for a relatively well known site—the Osborn Prairie of Oktibbeha County. In Alabama, Schotz and Barbour (2009) listed *A.*

gerardii as a common species at only one of their ten best sites for Black Belt prairie in the state—Pleasant Ridge in Greene County—and they did not list *Tripsacum* at any site. Species that were originally associated with *A. gerardii* are difficult to discern from the literature, and remnants of their populations may often be suppressed in non-flowering condition by encroaching woods. Based on general knowledge, these species probably included some that are now inconsistently documented or rare in the region, e.g., *Agalinis auriculata*, *Desmodium ochroleucum*, *Echinacea purpurea*, *Prenanthes aspera*, *Silphium integrifolium* (or perhaps *S. glabrum* in more brushy transitions), *Solidago rigida* (especially var. *rigida*), and *Veronicastrum virginicum*.

(h) Upland thickets, often in drier (h1) or damper (h2) transitions to woods. Shrubby transitions to upland or riparian woods often have distinctive species that are not typical of open grassland or deeper woods. More thorny variants were probably associated with larger herbivores before human interferences (Kaye 1974). Distinctive examples of such vegetation are still widely scattered but generally restricted to small patches, narrow strips, or truncated woodland edges. There is only one variant that has been described by NatureServe (2010) from the blacklands of southeastern states, in the Cook Mountain Prairie of Louisiana (NVC 3879): *Crataegus spathulata-Cornus drummondii-Berchemia scandens*. Similar vegetation does occur in the Black Belt of Mississippi and Alabama (Leidolf and McDaniel 1998; Schotz and Barbour 2009; NatureServe 2010, as part of NVC 4664). Thickets in the blacklands of central Georgia can be included for a broader definition, with *Cornus asperifolia* Michx. instead of *C. drummondii*, and with *Celtis tenuifolia* Nutt. instead of *C. laevigata* (Echols and Zomlefer 2010).

There are several historical indications of shrubby bands along edges of upland oak woods and in riparian zones, plus "isolated baskets" or "scattered clumps" mixed with the prairies, fields or villages. Sources extend from diaries of the De Soto expedition in 1540 (Rostlund 1957, Clayton et al. 1993) to Nairne (1708), Bartram (1791), Jones (1833), Gosse (1859), Hilgard (1860), Mohr (1901), Harper (1913a,b) and Lowe (1921). Nairne (p. 57) noted: "***on the Top of these knolls live the Chikcasaws, their houses… with their…plum trees about them.***" In the abandoned Chickasaw Old Fields, Jones noted "small... cottonwoods, persimmon, bushes, wild plum, briers, and grass." In Dallas County, Alabama, Gosse did not list cedar anywhere, but reported from the prairies that "Several species of Thorn (*Crataegus*) grow in impenetrable thickets or in single bushes over their surface, and one or two kinds of wild plum, bearing a harsh sour sloe or bullace, are often mixed with them" (p. 75). Similar notes of "crabapple thickets", "haws" and "plum" come from early descriptions of the Jackson Prairie (Moran et al. 1997).

In general, these thickets originally had much Rosaceae, with plums (*Prunus angustifolia, P. umbellata*), hawthorns (especially *Crataegus engelmannii*; see also, Mohr 1901), or crab-apples probably *Malus angustifolia*). Other locally common thicket-forming species are indicated by pre-1950 accounts (especially *) or by more modern observations (especially #): *Berchemia scandens*#, *Celtis laevigata**, *Cercis canadensis*#, *Cornus* (*drummondii*#, *florida**), *Diospyros virginiana**, *Frangula caroliniana*#, *Gleditsia triacanthos**, *Ilex decidua**, *Juniperus virginiana*#, *Maclura pomifera*#, *Ptelea trifoliata*, *Rhus* spp. (*aromatica, copallina, glabra*)#, *Sideroxylon* (*lanuginosum, lycioides*)#, *Ulmus alata*# and *Vitis* spp. (including *rotundifolia** on more acid soils). Some species of such vegetation are now rare, at least within the region, notably *Crataegus ashei, C. triflora* and *Rhamnus lanceolata* (Schotz and Barbour 2009).

(i) Red cedar woods. Red cedar (*Juniperus virginiana*) appears to have been uncommon or rare in the Black Belt of Mississippi before De Soto (Peacock and Miller 1990). In 1832, it made up only ca. 0.3% of the recorded trees across the Black Belt of Sumter County, Alabama (Jones and Patton 1966). Mohr (1901) noted "cedar hammocks" in Alabama "on the highest swells of the plain where the strata of the rotten limestone are overlaid by lighter loams." In the Black Belt of Mississippi, Lowe (1913, 1920) reported red cedar only from ledges where limestone comes to the surface or as scattered clumps in low or wet areas. Harper (1913a) noted red cedar only once in Mississippi, though he stated: "It is rather common in the black belt of Alabama."

Red cedar has now become locally dominant in woods and thickets on calcareous soils at various elevations. Older stands tend to occur on drier bluffs and ridges adjacent to chalk outcrops, sometimes with the Ripley Formation nearby at higher elevation (e.g., Morris et al. 1993, Leidolf and McDaniel 1998, Hill et al. 2009). In addition to direct colonization of old fields, red cedar can invade thickets of the species noted in the previous section (h), along with sugarberry (*Celtis laevigata*), ashes (*F. americana*), scattered oaks (especially *Q. muhlenbergii*), and other trees. NatureServe (2010) has outlined a generalized type (NVC 7747): *Juniperus virginiana*-(*Celtis laevigata*, *Prunus angustifolia*, *Sideroxylon lycioides*). Similar woods have been well-documented in other blacklands, from Louisiana (Bekele et al. 2006; together with species of *Crataegus*, *Diospyros* and *Berchemia*) to Georgia (Echols and Zomlefer 2010; where *Celtis tenuifolia* often occurs instead of *C. laevigata*). Schauwecker (1996, 2001; see also Weiher et al., 2004) has shown that succession to red cedar causes ground cover to decline abruptly in biomass and richness, usually leading to a few relatively common shade-tolerant species. However, more sun-loving species can prosper locally in thinner woods, including the vine, *Berchemia scandens*, the sedge, *Carex cherokeensis*, and the alien legume, *Lespedeza cuneata*, which often persists from plantings in old fields.

The research of Schauwecker (2001), Weiher et al (2004) and Bekele et al. (2006) has indicated that, as well as the increase in shade during succession from grassland to cedar to hardwoods, there is increased organic matter in the soil, increased moisture-holding capacity, decreased pH (from ca. 7.5-8.25 to ca. 6.5-7.5), and shifts in the balance of available minerals (especially from Ca to Fe). Also, Hill and Brown (2010) have documented a distinctive group of ant species associated with red cedar in the Black Belt.

(j) Submesic mixed hardwoods. These varied woods occur on relatively moist but well-drained soils, usually in areas protected from disturbance on steeper bluffs or sheltered hillsides, or along streambanks where they grade into the riparian woods of broader floodplains, as outlined below (type m). Such vegetation is widespread in small patches and riparian strips, especially in peripheral parts of the region, but there have only been a few miscellaneous published notes on composition.

At the western side of the Black Belt in Mississippi, Ward (1987) used the 1834 survey to indicate red elm, hickory, ash, walnut and sassafras in groves of trees on lower slopes, along with post oak and blackjack on drier ground. In this same section, Hilgard (1860, p. 84) noted the following trees on hillsides with Paleocene limestone [using modern names]: *Quercus velutina, Q. falcata*, *Carya* sp., *Liriodendron, Juglans nigra, J. cinerea, Tilia* sp., *Magnolia* cf. *pyramidata*, and *Robinia pseudoacacia*; lower in the valley, he noted *Platanus, Gleditsia, Prunus* and *Cercis*. At the southern side of the Black Belt in central Alabama, Bartram (1791) noted: "Immediately after leaving the plains we enter the grand high forests. There were stately trees of the *Robinea pseudacacia* [sic], *Telea* [*Tilia*], *Morus, Ulmus, Juglans exaltata* [perhaps *Carya ovata*], *Juglans nigra, Pyrus coronaria, Cornus Florida, Cercis*, &c." In Alabama, some of the "cedar hammocks" described by Mohr (1901) were at least transitional to shrubs (*Asimina, Ilex, Forestiera, Zanthoxylum*) and hardwood trees: *Fraxinus americana, Quercus* spp. ("*laurifolia*" and "*texana*"), *Celtis laevigata, Ulmus americana* and *Acer floridanum* (Chapm.) Pax [= *A. barbatum* auct.].

More modern descriptions of hardwoods on calcareous soils in or near the Black Belt remain scattered, but somewhat consistent. At the southern side, Harper (1920) listed the commonest trees in "a small wooded valley" adjacent to his prairie: *Quercus* spp. (*muhlenbergii*, [*shumardii* var.] *schneckii*, *stellata*), *Fraxinus americana, Ulmus alata, Juniperus, Juglans, Liquidambar, Tilia and Liriodendron*. At the western side, Morris et al. (1993) listed typical trees of a NE-facing mesic bluff: *Quercus* spp. (*muhlenbergii, shumardii*), *Carya* spp. (*carolinae-septentrionalis, myristicaeformis*), *Fraxinus* spp. (*americana, pensylvanica*), and *Ulmus* spp. (*americana, alata*), plus lesser numbers of some mesic, shade tolerant species, *Acer floridanum, Aesculus glabra* Willd., and *Tilia americana* (sensu lato). In Alabama, Schotz and Barbour (2009) noted similar woods on slopes below prairies at several sites, with *Quercus* spp. (*alba, muhlenbergii, shumardii*), *Carya* spp. (*glabra, carolinae-septentrionalis, myristiciformis*), *Fraxinus* spp. (*americana*, *pensylvanica*), *Celtis* *laevigata*, *Ulmus* spp. (*alata, rubra*) and *Pinus taeda*. In the blacklands of central Georgia, the woods are somewhat similar, but more varied from damp to dry soils, i.e., with much more *Q. nigra* in general, locally *Q. pagoda* on terraces, and much transition to *Q. velutina* or *Pinus taeda* on more sandy uplands (Echols and Zomlefer 2010).

There are several, varied types in the National Vegetation Classification that might be partly applied here (NatureServe 2010), but only a few well-described types have been directly linked with blacklands. These include: (1) *Quercus stellata-Q. muhlenbergii/Schizachyriumm scoparium-Sorghastrum nutans* (NVC 4670), which is a transition to open post oak woodland in the Black Belt; (2) *Quercus durandii-Fraxinus americana-Quercus muhlenbergii/Rhus aromatica-Cornus drummondii* (NVC 7256), which is a transition to dry thicket described for the Jackson Prairie of Louisiana; and (3) *Quercus muhlenbergii/Q. durandii-Cercis canadensis/Viburnum rufidulum/Scleria oligantha*, which is mixed with *Q. velutina* in the blacklands of central Georgia, and grades into *Crataegus-Cercis* thickets (Echols and Zomlefer 2010). More mesic woods with less oak, as noted by Morris et al. (1993), could be included within the broadly defined Upper East Gulf Coastal Plain type: *Acer floridanum-Aesculus glabra-Carya myristicaeformis-Quercus shumardii-Q. muhlenbergii* (NVC 4671; see also NVC 7971 of Arkansas).

Lowlands with Alluvial Soils. Distinction from uplands is arbitrary in many areas, especially where topographic relief is slight. Calcareous uplands and toe-slopes contain local colluvium and alluvium along swales and gullies that often lead gradually into the more the extensive—and locally exogenous— alluvium on terraces along broader valleys. Agriculture tends to be especially intense in these broad transitions.

(k) Lowland prairie or open woodland. Several historical accounts indicate that extensive grasslands (“prairies” or “savannahs”) occurred locally on relatively well drained toe-slopes and bottomlands that were occupied and cultivated by native tribes, especially the Chickasaw: Nairne (1708), Atkin (1755, p. 67), Adair (1775, p. 352), Romans (1775, p. 124), Baily (1797, p. 30), Nutt (1805, p. 43), and other sources cited by Barone (2005) and Cook (2010). Atkin's account of the Chickasaw, with only “350 adult men” remaining, provides special insight: “These Indians live in seven Towns, having each a Palisade Fort with a Ditch, in an open rich Champain Plaine about ten Miles in Circumference, accessible only on one side, being almost surrounded by Swamps in a circular manner, about a mile from any running Creek...” Similar notes came from lowlands along the Alabama River and its tributaries (e.g., D. Taitt 1772, quoted in Rostlund 1957; Bartram 1791, Hawkins 1798-99).

It is likely that gamagrass (*Tripsacum dactyloides*) was dominant in some of these areas, along with big bluestem (*Andropogon gerardii*) and other tall grasses, especially on vertisols that start wet in the spring but often dry out and crack during the summer and fall (Myers 1948). Harper (1913a) found that gamagrass was the most common native grass in the Black Belt region of Mississippi, and it was also frequent on lowlands within adjacent regions to the west, i.e., the Pontotoc Ridge on more sandy soils, and the Post-oak Flatwoods on stiff clays.

In early settlement, livestock no doubt concentrated on such land and greatly reduced the palatable taller grasses. In farmland of the northern Black Belt, Romans (1775) stated: “the earth is very nitrous... this produced a grass of which cattle are so fond as to leave the richest cane brakes for it; and notwithstanding the soil appears barren and burnt up, they thrive to admiration.” In the Jackson Prairie region, A.J. Brown (1894; cited by Moran et al. 1997) contrasted two types of grassland: (1) the true “prairie grass” of former “woodland prairie” with post oak, then much converted to cotton on deeper, moister soils [Hilgard’s “black prairies”]; and (2) the “upland grass” of drier “shell prairies” that were much less productive for agriculture and becoming scrubby [Hilgard’s “bald prairies”]. Regarding (1), he stated: “... of which the cattle were very fond and which was a great milk and fat producer. Most of these grasses have become extinct, or so dwarfed by constant grazing and trampling by stock, as not to be observed as an original grass.”

Such vegetation has now become almost all converted to fields for corn, cotton and soybeans, except for the frequent strips of land with gamagrass along rights-of-way and ditches. NatureServe (2010) has outlined a *Panicum virgatum-Tripsacum* *dactyloides* type for the Grand Prairie of Arkansas (NVC 4624), but has not yet listed a *Tripsacum* type for the Black Belt in Mississippi or Alabama. Nevertheless, gamagrass is now widely promoted for native forage and general restoration by the Extension Service of Mississippi State University at Starkville.

(l) Lowland canebrakes and other thickets. Originally, there were extensive canebrakes dominated by *Arundinaria gigantea* on some lowlands, with the tallest cane on levees close to larger streams and rivers (Hawkins 1798-99; Nutt 1805; W. Roberts in Darby 1818; 1834 survey summarized in Ward, 1987; Lyell 1849; Mohr 1901; and other sources of Rostlund, 1957). Mohr even noted: "So conspicuous was this formation in the western part of the plain that it is called emphatically the "canebrake region"" (see also, Cleland 1920). This vegetation was presumably most widespread on sites that were frequently flooded for short periods, but probably burned less often than the lowland prairies (type k) or associated fields. However, cane was "a delightful range for stock" (Hawkins) and its soil was highly suitable for farming after clearance. Cane declined rapidly to become a minor species in the settled landscape, here (Harper 1913a) and elsewhere in its range (Platt and Brantley 1997).

From these early accounts, it appears that several small or shrubby trees were also locally abundant in thickety transitions between grassland—or cultivated fields—and woodland of various types: including edible grapevines (*Vitis* spp.), plums (*Prunus* spp.), pawpaws (*Asimina triloba*), persimmons (*Diospyros virginiana*) and mulberries (*Morus rubra*). NatureServe (2010) has outlined a generic canebrake type (NVC 3836), plus some bottomland forest types with cane that can be applied or modified for the Black Belt region (especially NVC 8429, 2099, 3836).

(m) Riparian woods. From historical to modern sources, mixed hardwood forests of diverse types have often been noted along banks and terraces of streams and rivers within the Black Belt and other nearby blacklands (D. Taitt 1772, quoted by Rostlund 1957; Bartram 1791; Hawkins 1798-99; 1834 survey summarized by Ward 1987; Hilgard 1860, Mohr 1901, Harper 1943, Lowe 1921, Whitehead and Sheehan 1985, Morris et al. 1993, Echols and Zomlefer 2010; NVC 2427, 2431, 7335, 7340, 7353, 7915). Frequent trees have included *Acer* spp., *Aesculus* spp., *Betula nigra*, *Carya* spp., *Celtis laevigata*, *Fraxinus* spp., *Gleditsia triacanthos*, *Juglans nigra*, *Liquidambar styraciflua*, *Morus rubra*, *Nyssa* spp., *Platanus occidentalis*, *Populus* spp., *Prunus serotina*, *Quercus* spp., *Salix nigra*, *Tilia* spp. and *Ulmus* spp. Several shrubs and vines are also common, and there is local intergradation with canebrakes (type l).

Such woods varied much in width, structure and composition depending on the size of streams, hydrology, soil conditions and management. Groves of nut trees and persimmons on low slopes or terraces were noted by some early observers, and may well have been selected by the inhabitants, based on diaries from De Soto's 1539-43 expedition (Clayton et al. 1993), Bartram (1791), and others cited by Rostlund (1957). Along the larger rivers of central Alabama, where alluvium is often sandier, Mohr (1901) added listed *Fagus*, *Liriodendron* and *Magnolia*, and other early observers noted "poplar" [probably *L. tulipifera*], "laurel" [probably *M. grandiflora*], "cypress", "bay" and "white cork" (Rostlund 1957).

(n) Wooded swamps, sloughs and ponds. Such vegetation is widely scattered across the region, but there are few extensive remnants in a relatively natural condition (Mohr 1901, Harper 1913b, Whitehead and Sheehan 1985, Leidolf and McDaniel 1998). Before agricultural conversions and excessive hunting, beavers—and even people in some areas—probably formed extensive dams on lowlands of the Black Belt (Ward 1987, Cook 2010). Nairne (1708; p. 47, 50) noted "multitudes of Beavor dams" among the Chickasaw villages. Black willow may have been a typical tree around more open wetlands within the grassland (e.g. Roman 1775; p. 15-16).

Some larger sloughs are distinguished by overcup oak (*Quercus lyrata*; cf. NVC 2424) or water tupelo (*Nyssa aquatica*; cf. NVC 2419). However, bald cypress (*Taxodium distichum*) is largely absent, except locally along larger streams and rivers. Paleoecological studies of an oxbow along the Tombigbee River detected bald cypress only after 1800, and "suggest that the modern vegetation of *Nyssa*-*Taxodium* developed very recently... Increased discharge due to European land clearance may have increased both water level and the length of time that standing water was present in the oxbow sufficiently to permit growth of both cypress and *Orontium*" (Whitehead and Sheehan 1985).

(o) More open ponds and marshes. These must have existed locally before European settlement, for example around beaver ponds. They do exist in varied contexts today, but generally in rather small patches that tend to escape attention, description and conservation. For example, the valley of Sakatonchee Creek in Chickasaw County, Mississippi, is locally dominated by marshy vegetation. On more open lowlands managed by native people before 1540, such vegetation may have graded into the wetter grassland indicated above (types k and g).

DISCUSSION

Based on the preceding notes, Fig. 2 presents a hypothetical scheme of associations between vegetation types and soil series. Gradients among vegetation types are overlayed on the catenas of soil series (Fig. 1). It is hypothesized that each vegetation type was formerly most extensive on or near their overlayed soil series during pre-Columbian times. However, some modern descendants of original vegetation types cannot be reliably associated with particular soils today, especially on damper or lower ground with more drastic changes in disturbance regime, agricultural development and fragmentation. These more uncertain associations are indicated with question marks.

This framework does provide a useful initial model, but deserves refinement. It will be important to cross-reference such schemes in more detail with descriptions and mappings of vegetation types in the National Vegetation Classification and State Heritage Programs. Moreover, robust classifications should be built on a more detailed review of raw data from across the region. Also, such classification should ultimately be rooted in models of major ecological gradients and dynamic processes, rather than just hierarchical concepts of formations, alliances, associations and the like.

The gradient outlined here from lowland to upland vegetation is readily related to mapped soil series. However, the independent gradient from closed forest to open grassland is clearly influenced by dynamic factors that can reduce consistent associations with soil, even among better remnants of the original vegetation. Such factors have probably changed much during recent centuries. Deeper woods have probably remained best developed on relatively mesic, well-drained sites or on swampy soils. But red cedar has spread much into former prairies, while the original thickets and other transitions between woodland and grassland have probably declined considerably. Native grassland appears to have originally occurred on a wide range of soils, but became greatly modified after European settlement. Better remnants are now mostly restricted to shallower chalky soils (left-center of Figs. 1 and 2). More disturbed variants of native grassland, grouped under type (e) above, may have been concentrated below actively eroding exposures of chalk before settlement, on local alluvial soils such as Griffith (Fig. 1), but now appear to be widespread on several soil series.

Figure 2.

TYPICAL PARENT MATERIAL	TYPICAL TOPOGRAPHY MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil	TRANSITIONAL	INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep	TRANSITIONAL	LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		(a) post oak woods (or deeper woods) * * * * * * * * *	(a/b1) post oak or oak-pine woods * * * * * * * * *	(a/b2) post oak or blackjack oak woods?	(n2) swampy woods with post and water oak?
Sandy uplands or high terraces: sandy loams to fine sandy loams		(a) post oak woods (or deeper woods) * * * * * * * * *	(b1) oak-pine woods * * * * * * * * *	(b2) blackjack oak woods? * * * * * *	
Clayey uplands: acid clay and locally sand or silt overlying chalk	(a) post oak woods (or deeper woods) * * * * * *	(a) post oak woods * * * * * *	(a/b2) post oak or blackjack oak woods * * * * * * * * *	(a/b2) post oak or blackjack oak woods * * * * * * * * *	(c2) wetter acid grassland
Clayey uplands: more influence of acid clay than chalk; not loamy		(a) post oak woods * * * * * *	(b2) blackjack oak woods or grassy mixes * * * * * *	(c1) drier acid grassland * * * * * * * * *	
Chalky uplands: gentle slopes with influence of overlying clay		(i/h1) red cedar, drier thickets, or grassy mixes? * * * * * *	(d1) xeric tending chalk grassland * * * * * * * * *	(d2) xero-hydric chalk grassland * * * * * *	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	(i) red cedar woods or grassy mixes	(f) subxeric chalk grassland * * * * * *	(e) transitional chalk grassland; wider if disturbed * * * * * * * * *	(g2) more hydric chalk grassland * * * * * *	
Chalky uplands: loamy toe-slopes, swales and alluvial transitions	(j1) submesic woods below bluffs & on toes	(h2) damper thickets or grassy mixes? * * * * * *	(g1) more mesic chalk grassland? * * * * * * * * *	(k) lowland grassland? **************	
Floodplains: loamy alluvium along perennial streams		(j2) more mesic woods on toes & terraces? * * * * * *	(j3) submesic woods on terraces * * * * * * * * *	(l) canebrakes and varied transitions? **************	(k) lowland grassland (marshy)? * * * * * *
Floodplains: deep clayey alluv. along streams and backwater sloughs		(m) more mesic riparian woods * * * * * *	(m) more hydric riparian woods * * * * * *	(n1) swampy woods	(o) marshes and ponds?

Figure 2. Diagram showing suggested associations of gradients in original native vegetation to catenas of soil series in the Black Belt region. Lettered codes in parentheses (a to o) refer to the sequence of notes in text. Shading indicates the general degree of openness in the vegetation. Asterisks at the bottom of each cell indicate the general degree of agricultural conversion, based on descriptions of USDA (2010a), overall review of literature and general observation. The densest asterisks indicate land that was most suitable for crops in early agricultural development. Moderately dense asterisks indicate additional land that is now generally used for row crops, especially cotton, corn or soybeans. Less dense asterisks indicate that pasture and hay-production are at least as extensive as row crops. Lack of asterisks indicates that native vegetation is at least as extensive as agricultural land—native vegetation is mostly woody, except for the concentrations of prairie remnants on Binnville and Sumter soils

These concepts can be tested. Research on modern or historical vegetation of the region could record soil types in a systematic fashion at study sites. But it will be important for ecologists to add their own local precision in mapping soils, since existing maps of the USDA are not reliable at scales less than 10-100 acres [4-40 ha]. And, for more general application of soil classification, it will be useful to consider series within the context of ‘catenas’—a traditional concept in soil science that deserves more regular application across the ecological literature of eastern North America. More intensive, separate analyses of spatial variation in both soil and vegetation could allow more definitive correlations between soil and vegetation. Residual variation or ‘noise’ in those relationships could then be separated statistically to examine potential involvement of changes in ‘disturbance regime’—defined broadly, from climatic disruptions to human land uses—and especially changes within recent centuries. In this way more dynamic models of interaction between soil and vegetation might be advanced.

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Water Quality Studies On The Lower Mississippi River In Port Gibson, MS

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ABSTRACT

Water quality is closely associated with the surrounding environment and land use. It can be affected by community uses such as agricultural, urban and industrial use and use for transportation of goods and recreation. (Figs. 5-8) Water quality standards were adopted by the State of Mississippi in 1995 for interstate, intrastate, and coastal waters. The policy was adopted to protect and upgrade lotic water quality within the State. This study was initiated to determine the presence of pollutants in the Mississippi River and to find out if the River meets the Mississippi water quality criteria(MSWQC). During the month of October 2005, (Fall) and March 2006 (Spring) water samples were collected at two different locations, respectively, from the Mississippi River in the Port Gibson area of Mississippi State. The samples were taken to the laboratory and tested according to the methods indicated in the LaMotte water pollution detection kits. There were seventeen parameters tested and the average readings recorded. Based on the results, the Mississippi River met the Mississippi water quality criteria with the exception of calcium, water hardness, and dissolved oxygen (DO). A need to engage in continuous or periodic monitoring of the quality of the Mississippi River is stressed.

INTRODUCTION

The Mississippi River is the third longest river (approximately 63,000km) in the world rising from Lake Itasca, Minnesota, in the north and emptying into the Gulf of Mexico in the south; It is considered the Nation's principal river. Its economic and ecological importance is enormous. It serves as a source of drinking water for many States and an avenue for shipment of grains and other goods. It is believed that about 40 percent of the rivers of the continental United States drain into it.

Water quality is closely associated with the surrounding environment and land use. It can be affected by community uses such as agricultural, urban and industrial use and use for transportation of goods and recreation. Water quality standards were adopted by the State of Mississippi in 1995 for interstate, intrastate, and coastal waters. The policy was adopted to protect and upgrade lotic water quality within the State. The National Water Quality Inventory (NQWI), which the EPA instituted in 1972 under the Clean Water Act, is the primary source for measuring water quality in America. It evaluates rivers, lakes and estuaries based on ability to support aquatic life and fish consumption. (Pacific Research Inst. 1999) Acholonu, et. al. (2005) conducted a study on the Big Sunflower River and the Yazoo River in Mississippi to find out if they met the water quality standard for fresh water bodies in Mississippi. Based on the water quality parameters measured, both the Big Sunflower and the Lower Yazoo River met the Mississippi Water Quality standard. Hopkins and Acholonu (2005) conducted a study titled, "Assessment of Water Quality in two lotic bodies of water in

Jefferson County, MS" and still reached the same conclusion. This study was initiated to determine the presence of pollutants in the lower Mississippi River and to find out if the River meets the water quality criteria of Mississippi.

MATERIAL AND METHODS

During the month of October 2005 and March 2006, water samples were collected at two different locations(about 50 meters apart) from the Mississippi River in the Port Gibson area, Claiborne County, MS about 25 miles north of Alcorn State University and in the vicinity of the Grand Gulf Military Park. (Figs. 1-2)The samples were taken to the laboratory, and tested as was done by Acholonu and Jenkins (2007) and according to the methods indicated in the LaMotte water pollution detection kits supplied by LaMotte Company, Chestertown, MD.

The SHI model 89 handheld Dissolve Oxygen (DO) and Temperature meter was used to measure the dissolved oxygen and temperature. Seventeen different parameters were tested (see Table 1). The test results were analyzed.

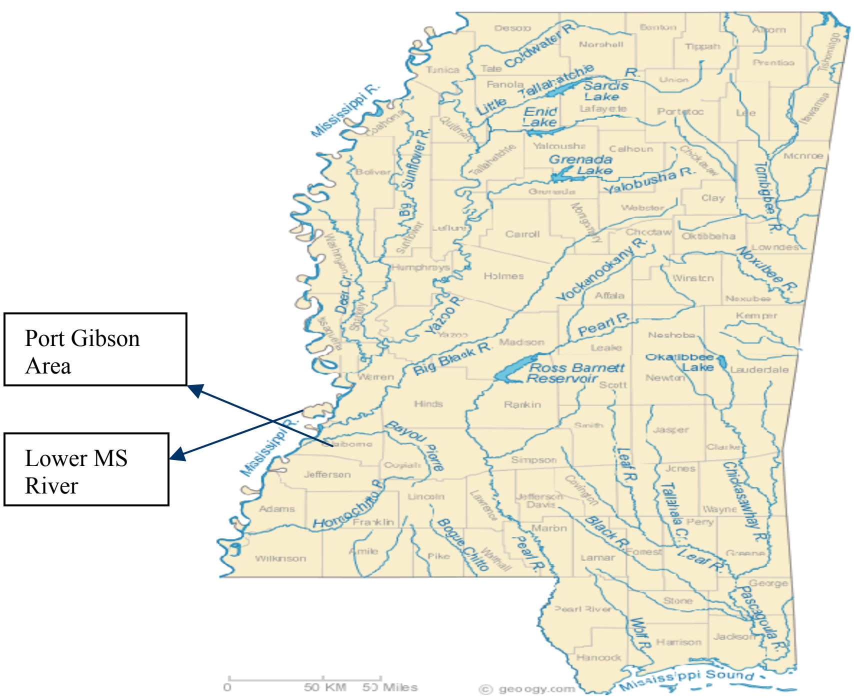

FIGURE 1 Map of Mississippi showing Mississippi River and the study area

FIGURE 2 Picture showing the water samples collected from the Mississippi River in the Port Gibson Area by Dr. Acholonu and students

RESULTS

A comparison between the Fall, 2005, and Spring, 2006 test results shows that Alkalinity and Ammonia- Nitrogen were 0ppm for both seasons, while the reading from other parameters were different as follows: Calcium, F= 230 ppm, S= 80 ppm; Carbon Dioxide, F= 6 ppm, S=5 ppm; Chlorides, F= 16.35 ppm, S= 46 ppm; Dissolved Oxygen, F= 2.28 ppm, S= 1.55 ppm; water hardness F= 194.6 ppm, S=121.5 ppm; and Magnesium, F= 60 ppm, S= 43ppm (Table 1 and Fig. 3).

Table 1 CHEMICAL PROFILE OF MISSISSIPPI RIVER: FALL 2005 AND SPRING 2006

	Fall	Spring	Acute/Chronic
Total Alkalinity	0	0	3.08/ .02
Ammonia-Nitrogen (NH_3)	0	0	10
Calcium (Ca) (WHO)	230	80	200
Carbon Dioxide (CO_2)	6	5.5	10

Chlorides	16.35	46	75/60
Chlorine (Cl_2)	0	N/A	19/11
Copper (Cu)	0	N/A	8.85/6.28
Dissolved Oxygen (DO)	2.28	1.55	4
Fluoride (F)	0	N/A	1.2
Hardness	194.6	121.5	50
Iron (Fe)	0.38	N/A	0.2
Magnesium (Mf)	60	43	150
Nitrate	N/A	0.4	10.0
pH	N/A	6.25	
Phosphate	N/A	0	
Silica	N/A	5.25	
Sulfide	N/A	0	

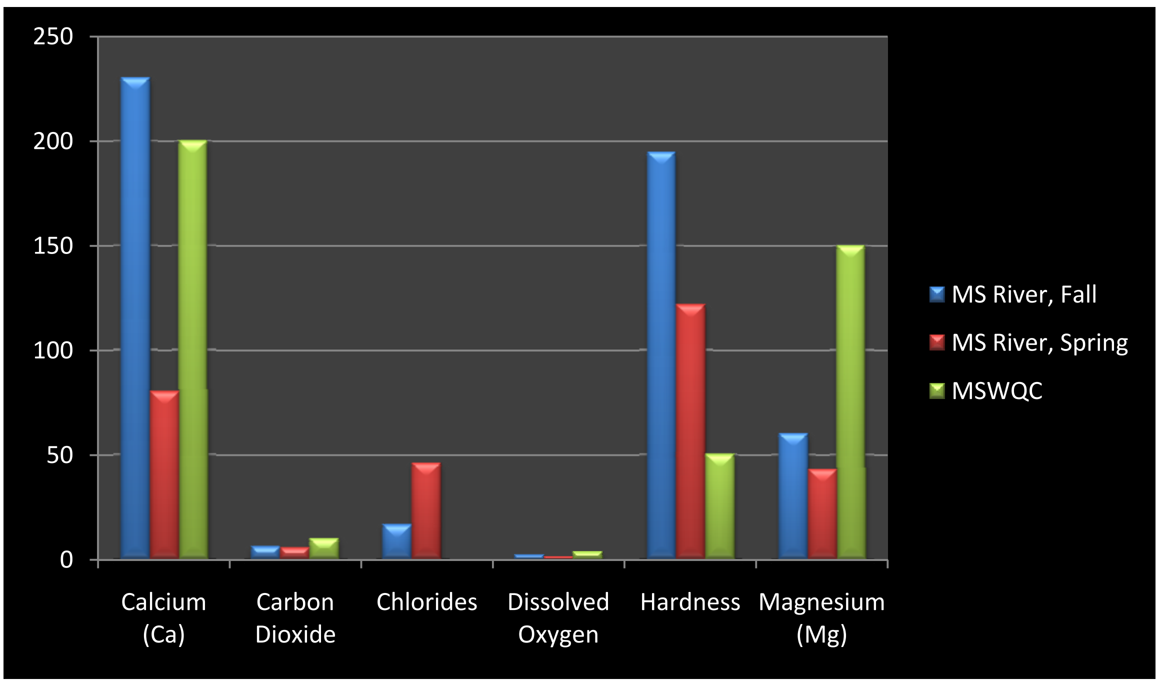

FIGURE 3 Graph showing chemical parameters readings and MSWQC

DISCUSSION AND CONCLUSIONS

Typical uses of the water body include public water supply, propagation of fish and wild life, recreation, agriculture, industrial processes, and navigation (EPA, 1999). As such periodic assessment of the quality of different waterbodies is essential. This is more so as there is much public apprehension about the effects of water pollution (Renn, 2001). What were tested here were chemical parameters (chemical profile). Other aspects of water pollution studies should be conducted by subsequent investigators.

The analysis of the test results showed several similarities and differences in the samples collected during the Fall of 2005 and the Spring of 2006 as indicated in the results,(Table 1 and Fig. 3). The differences noted, occurred in both the Fall and Spring. In the Fall, the Mississippi River's highest pollutants were calcium with a concentrations of 230 ppm, water hardess,194.6 ppm, and magnesium, 60ppm. This was the same in the Spring but the concentrations were all lower(80ppm, 121.5ppm, and 43ppm respectively). DO was low in both seasons. The changes could be attributed to the fact that several factors affect water quality. To accurately measure water quality, a researcher must take into consideration water source, velocity, volume, depth, pH level, photosynthetic activity, seasonal variations and even time of day (Pacific Research Inst., 1999). Based on the water quality parameters measured, the Lower Mississippi River in the Port Gibson Area met the Mississippi water quality standard, with the exception of calcium (230/200ppm) and water hardness(194.6 /50 ppm, 121.5/50 ppm)concentrations. DO was also low or below the threshold(2.3/4ppm and 1.55/4ppm respectively) and gives cause for concern as a low DO content is often an indicator of organic pollution(Brower at al. 1998). This observation was also made by Okorie and Acholonu(2008) with respect to Nworie River. As observed by them (loc. cit),the oxygen concentrations were most probably a result of decay of large qualities of organic materials discharged into the river or drifting from the upper to the lower Mississippi River on its way to emptying into the Gulf of Mexico.

This study is the first of a series of water quality studies we plan to conduct on the Lower Mississippi River in an effort to monitor its pollution level and usability for various purposes and collect spatial and temporal data for subsequent ecological analysis. Despite its significance the Mississippi is an "orphan" in terms of effort to monitor its water quality and reduce pollution. Currently there are no significant system to monitor pollution levels along the river's entire length (Frueh 2007). These statements vividly demonstrate the need to conduct continuous or periodic water quality studies on the Mississippi River.

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The Phylogenetic Position Of Subfamily Monotropoideae (Ericaceae) Inferred From Large Ribosomal Subunit (26S) rRNA Gene DNA Sequences

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INTRODUCTION

Obligate myco-heterotrophs are non-green plants that obtain fixed carbon from fungi (Bidartondo and Bruns, 2002). Such plants have arisen independently in many plant families including the Orchidaceae, Burmanniaceae, Corsiaceae, Scropulariaceae and Gentianaceae. Several closely related myco-heterotrophic species occur in subfamily Monotropoideae of family Ericaceae. According to Kron et al. (2002), the Monotropoideae consists of an autotrophic tribe, Pyroleae, and two myco-heterotrophic tribes, Pterosporeae and Monotropeae. However, there has been little consensus concerning the circumscription or phylogenetic position of this subfamily. For example, some authors placed the autotrophic members in family Pyrolaceae and the mycoheterotrophic members in family Monotropaceae (e.g. Rydberg, 1914; Small, 1914; Cronquist, 1981; Anderberg, 1992). Other authors combined the two groups in family Pyrolaceae (e.g. Copeland, 1939, Lawrence, 1965) and others have positioned both groups within Ericaceae (e.g. Copeland, 1941, 1947, Wood, 1961, Stevens, 1971, Wallace, 1974, Takhtajan, 1980, Judd and Kron, 1993).

Aphylogeny inferred from partial 28S rRNA gene sequences by Cullings (1994) indicated that the myco-heterotropic Monotropoideae are polyphyletic. However, due to possible misidentification of specimens used in that analysis, Cullings (2000) stated that no taxonomic conclusions regarding members of the Monotropoideae should be drawn from those data.

A phylogenetic analysis of *rbc*L sequences by Kron and Chase (1993) suggested that the Monotropoideae are positioned between the basally diverged *Enkianthus* and all remaining representatives of Ericaceae. A phylogenetic study using 18S rRNA sequences separately and combined with *rbc*L sequences by Kron (1996) recovered topologies that suggested various positions for the Monotropoideae with Ericaceae. Results from that study also suggested that the monotropoideae are monophyletic but that the myco-heterotrophic members may form a paraphyletic group. From their phylogenetic analysis of Ericaceae using both morphological data and *mat*K, and *rbc*L and 18S molecular data, Kron et al. (2002) concluded that the subfamily monotropoideae is composed of the autotrophic tribe Pyroleae and two mycoheterotrophic tribes Monotropeae and Pterosporeae. In that study, the Enkianthoideae are positioned as the most basally diverged subfamily followed by the Monotropoideae which are sister to all remaining subfamilies in Ericaceae. However, the analysis by Kron et al. (2002) was unable to resolve the relationships among the tribes of the Monotropoideae.

The purpose of this study is to investigate the phylogenetic relationship of subfamily Monotropoideae with family Ericaceae. This Relationship is inferred from a maximum parsimony analysis using large ribosomal subunit (26S) rRNA gene DNA sequences.

MATERIAL AND METHODS

Scientific name, voucher information, and GenBank accession numbers for the taxa analyzed in this study are listed in Table 1. Based on the studies by Bremer et al. (2002) and Anderberg et al. (2002) representatives of Cyrillaceae are designated as outgroup (Table 1). An approximate 1 kb DNA segment of the 26S gene was sequenced for the taxa included in this analysis. Spanning base positions 4-969 in *Oryza sativa* (Sugiura et al., 1985), this segment is characterized by conserved segments and more variable expansion segments (Kuzoff et al., 1998).

Total DNA was extracted from tissue using the CTAB method of Doyle and Doyle (1987). DNA sequences were amplified via polymerase chain reaction (PCR) (Mullis and Faloona, 1987; Saiki et al. 1988) from total DNA extracted for the species listed in Table 1 with combinations of forward and reverse primers referenced in Neyland (2002). Amplification was achieved with Tfl enzyme (Epicentre Technolgies, Madison, WI), using the following thermocycling protocol: a hot start at 94°C for 1 minute, 55°C for 1 minute; 72°C for 3.5 minutes, a terminal extension phase at 72°C and an indefinite terminal hold at 4°C. The double stranded PCR product was purified with FQIAquick (Qiagen, Hilden, Germany) using the manufacturer's protocol. Two µl of each sample were electrophoresed in a 1.0% agarose mini-gel for quantification against a known standard. Automated sequencing was conducted on an ABI Prism 377 Sequencer with XL Upgrade (hosed at Louisiana State University, Baton Rouge, LA, USA) using ABI Prism, Big Dye Terminator cycle sequencing protocol (P.E. Applied Biosystems, Foster City, CA, USA) Sequences have been deposited in the GenBank database (Table 1).

Phylogenetic analyses were performed using the heuristic search algorithm with Phylogenetic Analysis Using Parsimony (PAUP) version 4.0b10 software (Swofford, 2002). A parsimony search of 1000 random stepwise addition replications was performed.

Transition/transversion rates were calculated using MacClade software (Maddison and Maddison, 2003). All characters, including transversions and transitions, were weighted equally. Gaps were treated as missing data. As a measure of clade stability or roubustness, bootstrap support (Felsenstein, 1985; Sanderson, 1989) was calculated. Ten thousand full heuristic bootstrap replications were employed in this analysis.

Table 1. Taxa used in this study. All in group members are from Ericaceae (sensu Kron et al.2002). Outgroup members are from Cyrillaceae. Voucher/accession data re give. Those taxa collected by Neyland are housed at the McNeese State University herbarium (MCN) that by N. G. Miller is housed by at New York State Museum (NYS). The voucher supplied by the Arnold Arboretum, Harvard is designated by the prefix "AAH." Vouchers for DNA extracts supplied by The Royal Botanic Gardens, Sydney and The Royal Botanic Gardens, Edinburgh are housed at the University of New South Wales (UNSW) and The Royal Botanic Garden Edinburgh (E) respectively. Frozen Tissue from which the DNA extract of *Sarcodes sanguinea* was derived is maintained at the Department of E.S.P.M., University of California, Berkley.

Taxon	Voucher/Accession	GenBank Accession
Ingroup		
Subfamily Monotropoideae		
Tribe Monotropeae		
Monotropa hypopihtys L.	Neyland 2037	AF543835
Monotropa uniflora L.	Neyland & Hennigan 1954	AF540062
Tribe Pyroleae		
Chimaphila maculate (L.) Porsh	Neyland 2049	AY294625
Moneses uniflora (L.) Gray	Neyland 2079	AY566296
Tribe Pterosporeae		
Pterospora andromedea Nutt.	Neyland 2078	AY368156
Sarcodes sanguinea Torr.	--	AY737249
Subfamily Enkianthoideae		
Enkianthus campanulatus (Miq.) Nicholson	Neyland 2125	AY804243

Subfamily Arbutoideae		
Arbutus unedo L.	E19810674	DQ067894
Arctostaphylos uva-ursi (L.) Spreng	Neyland 2094	AY596455
Subfamily Ericoideae		
Tribe Ericaea		
Erica carnea L.	Neyland 2092	DQ065768
Tribe Phylloidoceae		
Kalmia latifolia L.	Neyland 1905	AY856380
Tribe Empetreae		
Corema conradii (Torr.) Loudon	AAH 795-90-B	AY942693
Tribe Rhodoreae		
Rhododendron canescens (Michx.) Sweet	Neyland 659	AY561837
Subfamily Cassiopoideae		
Cassiope fastigiata (Wall.) D.Don	E19842198	AY942692
Subfamily Harrimanelloideae		
Harrimanella hypnoides (L.) Coville	N.G. Miller 10974	DQ065769
Subfamily Styphelloideae		
Tribe Archarieae		
Archeria racemosa Hook. F.	UNSW23608	AY870406
Tribe Epacrideae		
Epacris lanuginose Labill.	UNSW 22531	DQ065767
Subfamily Vaccinoideae		
Tribe Andromedeae		
Andromeda polifolia L.	E19772596	DQ065770
Tribe Vaccinieae		
Vaccinium elliottii Chapm.	Neyland 1189	AY561835
Outgroup		
Cliftonia monophylla (Lam.)Britt. Ex Sarg.	Neyland 2093	AY561839
Cyrilla racemiflora L.	Neyland 856	AY561838

RESULTS

Sequences were easily aligned by eye. Gaps were introduced to accommodate point insertions/deletions (INDELS) in the data set. INDELS could not be determined unequivocally to be homologous and, therefore, were not treated as characters. The heuristic search resulted in a single most parsimonious tree (Fig. 1) of 388 steps with a consistency index of 0.6624 and a retention index of 0.5691.

Absolute distances within the entire data set range from a minimum of 8 between *Archeria* and *Epacris* and a maximum of 100 between *Monotropa hypopithys* and *Harrimanella.* Transitions numbered 247 and transversions numbered 80. Therefore, the ration of transitions to transversions is about 3:1.

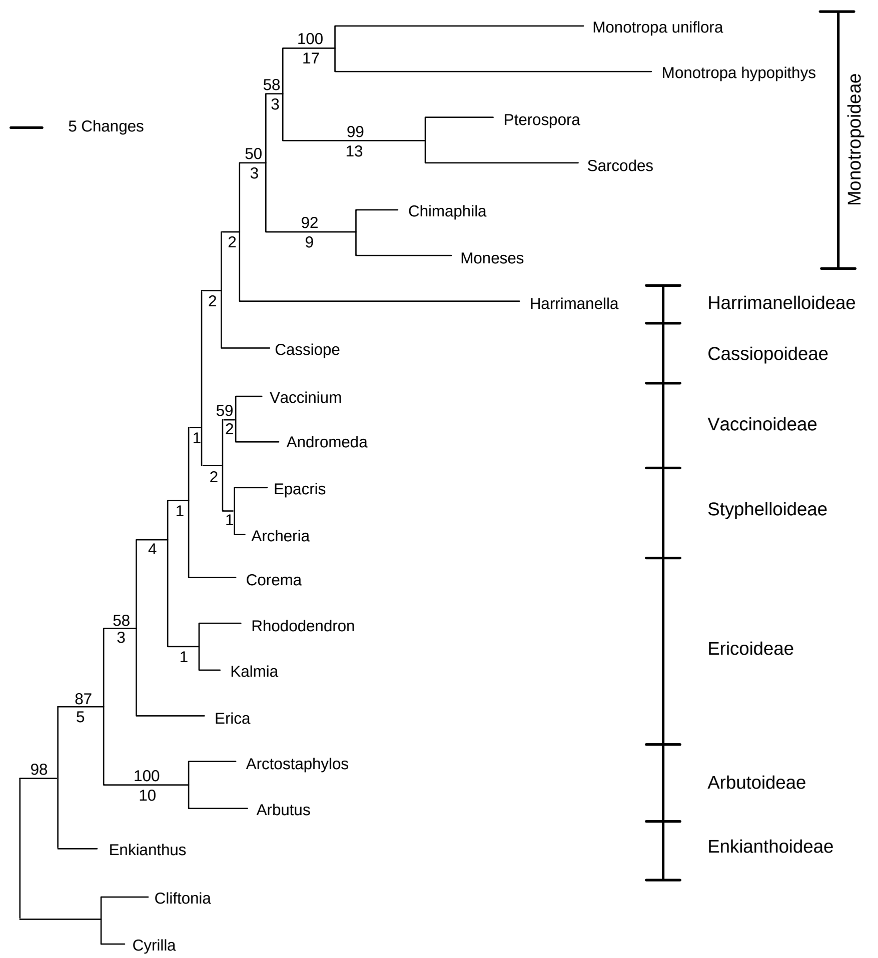

Figure 1. Phylogram recovered from a maximum parsimony heuristic search. Bootstrap values greater thatn 50% are indicated above each branch. Synapomorphies are indicated below each branch. Subfamily names are indicated in the side legend.

DISCUSSION

The findings of this study suggest that the Monotropoideae are derived within Ericaceae. The relationships among the Monotropoideae tribes received either moderate or strong bootstrap support as indicated by the phylogram (Fig. 1). This recovered topology supports Kron et al's (2002) taxonomy in which tribes Pyroleae, Pterosporeae and Monotropeae comprise a monophyletic group.

The derived position of the Monotropoideae in the phylogram (Fig. 1) supports the hypothesis of Henderson (1920) who suggested that these plants represent the end products of autotrophic members of Ericaceae and that of Furman and Trappe (1971) who considered them occupants of an advanced stage of evolution. However, support for the position of Monotropoideae has little bootstrap support (Fig.1). If all nodes that received less than 50% bootstrap support were collapsed, the Enkianthoideae would be the most basally diverged subfamily in Ericaceae followed by the Arbutoideae (Fig. 1). The basal position of the Enkianthoideae in this study agrees with that of Kron et al. (2002). However, the position of the Arbutoideae as sister to remaining subfamilies of Ericaceae in this study contrasts with the phylogeny recovered in the study by Kron et al.(2002) that suggested the Monotropoideae occupy this position. Perhaps the difference between the two studies is due primarily to the type of sequence data used. Kron et al. (2002) used chloroplast matK, and rbcL sequences and nuclear-encoded ribosomal 18S sequences. Because the chloroplast genomes of plants that no longer carry on photosynthesis are subject ot reduced selection pressures, their mutation rates are often elevated which can lead to homoplasy and misleading phylogenies (Felsenstein, 1978; Nickrent and Star, 1994; dePamphilis, 1995; Nickrent and Duff, 1996, 1996; Nickrent et al. 1998; Chase et al., 2000; Neyland, 2001, 2002; Neyland and Hennigan, 2003). Branches with excess substitutions will tend to share spurious synapomorphies with other long branches and, therefore, group with them, even if they are not closely related (dePamphilis, 1995). Therefore, the use of chloroplast sequences in constructing phylogenies that include obligate myco-heterotrophic plants is problematic. Kron et al. (2002) did use some nuclear-encoded 18S sequences in their analysis. However, the sole representative of the Monotropoid included in their 18S data was that of the autotrophic *Pyrola rotundifolia* of the tribe Pyroleae. Therefore, Kron et al.'s (2002) study included no nuclear-encoded sequences from the myco-heterotrophic members of the Monotropoideae. It is not surprising that phylogenies constructed from different genomes would produce different results, especially when obligate myco-heterotrophic plants are included.

The relationship of the tribes within the Monotropoideae remains equivocal. Although a large amount of data has been acquired and analyzed in this and other studies, there remains no robust support for any particular hypothesis. Perhaps the major problem with recovering a well-supported phylogenetic hypothesis of this group is a result of the high mutation rates associated with myco-heterotrophy. Although the case was made previously that reduced selection pressures on chloroplast genomes often leads to higher mutation rates and misleading phylogenies, results from this study also suggest that higher mutation rates may be associated with nuclear-encoded genomes as well. Specifically, the branch lengths, which are direct reflection of high mutation rates, for both tribes Monotropeae and Pterosporeae are comparatively long (Fig. 1). Therefore, the effects of long-branch attraction also may play a role in the recovered phylogeny of the present study. Thus, the systematic of the Monotropoideae remains a perplexing problem and is worthy of further research.

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Completed Abstracts

RISK PERCEPTIONS AND PREPAREDNESS FOR NATURAL DISASTERS

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Disaster preparedness is the process of avoiding risk by gaining knowledge, and preparing for a disaster before it actually occurs, which helps to minimize the effects of disasters including fear, anxiety and financial and economical losses. The purpose of this study was to determine the effects of risks perceptions of natural disasters on the preparedness for natural disasters. It was hypothesized that college students perceive natural disasters to pose a great threat to our society; however, they do not adequately prepare for natural disasters. 80 African American college students (males N=42, females N=38) were given the risk perceptions questionnaire and the household natural hazards preparedness questionnaire. Results of chi-square showed a significant difference between minor and major risk groups on perception and experience of wildfires (x^2= 4.045, p=.044), on perception and the last time they received to information on how to make their home safer (x^2= 11.240, p= .024), on perception and the fire department being an effective way to receive disaster preparedness information (x^2= 5.877, p= .053), on perception and the development of a reconnection plan (x^2= 6.701, p= .010), and on perception and considering the possible occurrence of a natural disaster when moving into their place of residence (x^2= 5.227, p=0.22). From the results it can be concluded that perceiving natural disaster as a minor or great risk sometimes may determine the way these groups will prepare themselves for natural disaster but there may be other factors involved for the preparedness for natural disaster which need further investigation.

RELATIONSHIP BETWEEN ATTITUDES TOWARD INTERCULTURAL SENSITIVITY, MULTICULTURALISM AND ETHNOCENTRISM AMONG COLLEGE STUDENTS

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The United States of America has an increasingly diverse population, which brings different traditions and civilizations into closer contact with one another (Rusen, 2004). Nevertheless, some Americans still lack acceptance, tolerance and openness to persons of different cultures. With the many studies on the color-blindness perspective it seems that more action is required to mitigate the overt racial conflict that is hampering the social practice of diversity that leads to ethnocentric idealism. The purpose of this study was to examine three constructs of cultural diversity in a sample of 80 undergraduate students. It was hypothesized that participants who express high intercultural sensitivity and multiculturalism will be less likely to be ethnocentric compared to those who are low in intercultural sensitivity and multiculturalism. The participants completed the Intercultural Sensitivity Scale (ICS) (Chen & Starosta, 2000), Multicultural Experience Questionnaire (MEQ) (Narvaez &Hill, 2009), and the Generalized Ethnocentrism Scale (GENE) (Neuliep, 2002). Correlation results showed significant negative relations with GENE and all five subscales of ICS which include interaction engagement (r = -.582; p < 0.01); respect for cultural difference (r= -.707; p < 0.01); interaction confidence (r = -.567; p < 0.01); interaction enjoyment (r = -.725; p < 0.01); and interaction attentiveness (r = -.397; p < 0.01). The results for the correlation indicated no significant relationship between the GENE and MEQ. It can be concluded from the results that those with high levels of intercultural sensitivity showed low levels of ethnocentrism, but high levels of multiculturalism did not result in low ethnocentrism.

ATTITUDES TOWARDS TERRORISM AMONG FEMALE AND MALE STUDENTS

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After the 9/11 terrorists attacks, the mindset of many Americans were skeptical of what would happen for the future. The aftermath of the 9/11 attacks had a devastating impact on the lives of not only victims, but adolescents and teachers (Noppe, 2006). Public reacted with panic and unrealistic views of the terrorist threat or with more controlled and rational evaluations of the changing security environment. The present research investigated the gender differences on the attitudes towards terrorism among college students. The Americans Attitudes "On War on Terrorism" questionnaire was distributed to 80 students, 40 females and 40 males. There were significant chi square differences between the responses of both males and females. Females agreed more on the attitudes towards the U.S. cooperation with the U.N. (x^2 = 12.488, p = .01), on the attitudes towards

the U.S. providing food and medical assistance (x^2 = 10.80 and a p = .02), on attitudes towards the country providing intelligence test that the U.S. should be able to provide it (x^2 = 6.99, p = .03). In reference to the U.S. broadening their campaign, males agreed more (x^2= 9.477, p = .02). Most females thought it would not be reasonable for the U.S. to reduce its level of conflict (x^2 = 8.93 and a p = .01), also most females did not support the idea of the U.S. supporting Jerusalem in having their capitals resulting (x^2 = 9.92 with a p = .00). Overall results showed that more females were concerned on the issue of terrorism than males.

COLLEGE STUDENTS' STRESS REACTIONS AND MATH ABILITY UPON THE MEDIA'S COVERAGE OF TERRORISM

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Media is rather powerful and can shape the public's opinion on certain incidences. Awareness of the media's role in today's society is extremely important due to its massive impact on the public's opinions, emotions, and actions. A study by Shoshani and Slone (2007) on 300 Israeli adults who randomly viewed both terrorism and non-terrorism media clippings revealed that there were higher levels of both emotional and attitudinal impact on the audience. This study investigated the different stress reactions and math ability of viewers who were shown clippings of the media's coverage on terrorism. It was hypothesized that the students who viewed the violent media clips (Experimental Group) will have a higher level of anxiety and would score lower on the mathematical ability than those who viewed the non-violent media clips (Control; Group). Data was collected from 40 college students (20 males, 20 females) who were given the STAIS-Anxiety Inventory (1970). Results showed that experimental group anxiety level was lower (M= 38.50, SD= 4.26) than the control group (M= 44.15, SD= 3.43) with a significant t (t=4.55 (37); p=.000). Results also showed that though the correct number of math problems for the control was higher (M=7.65, SD=.48) than the experimental group (M=7.25, SD=.63). But such a mean difference was not statistically significant (t=2.22 (38) p= .407). From the result it can be concluded that watching violent and non-violent media clippings in this study had no effect on anxiety score and math ability of the participants.

PARENTAL RELATIONSHIP AND ITS EFFECT ON COLLEGE STUDENTS' ROMANTIC RELATIONSHIP

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The purpose of this study was to assess the whether college students romantic relationship had an effect on their parent(s) marital status. Amato and Booth (2001) found that the quality of a parents' marriage has an effect on their children's marriages. It was hypothesized that parental marital status will have an effect on college students' intimate relationship. It was also hypothesized that there will be a relationship between college students' intimate relationship and their attachment level. Eighty undergraduate students were given the Multidimensional Relationship Questionnaire (MRQ) (Snell, 1996) and the Self-Report Measures of Adult Attachment (Brennan, Clark, & Shaver, 1998. There were three parental groups: Married, divorced and single. When ANOVA was conducted with parental marital status with all the subscales from the two questionnaires administered, only "fear of relationship" was found to be significant. To see the relationship between the two variables Correlation was conducted. Avoidance was positively correlated with relationship anxiety (r =.275, p<.05), relationship depression (r=.315, p<.01), fear of relationship (r =.390, p<.01). Anxiety was positively correlated relationship anxiety (r=.521, p<.01), relationship preoccupation (r=.427, p<.01), relationship motivation (r=.353, p<.01), relationship depression (r=.457, p<.01), external relationship control (r=.481, p<.01), relationship monitor (r=.241, p<.05), and fear of relationship (r=.323, p<.01). It can be concluded from the results that parental marital status did not have much effect on college student's romantic relationship but there is a positive relationship between college students' intimate relationship and their attachment level.

CHANGING VIEWS: SPIRITUALITY AND COPING STYLES OF AFRICAN AMERICAN

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African Americans are very religious and use their belief to cope with life hardships (James 2008). Older adults and young adults usually have different spiritual views and cope in different ways when faced with day to day decisions. Older adults are more prone to attending church rather than young adults. Most older adults take spiritual actions when coping with stress while young adults may cope differently. This study was conducted on 40 college students, 20 males and 20 females ages of 17-27, and adults 20 males and 20 females ages 45-56+,. to determine whether there is a difference in their views of spirituality and coping strategies. The participants were selected based on non-probability sampling from a college campus and churches. Two questionnaires were used. The Spiritual Involvement and Beliefs Scales, (Hatch, Burg, Naberhaus, and Hellmich, 1998), and the Coping Styles Inventory, Clifton, Addison, Campbell, Sarpong, that targets four different areas: Problem-Focused Engagement, Problem-Focused Disengagement, Emotion-Focused Engagement, and Emotion-Focused Disengagement. It was hypothesized that older adults would be more spiritual than younger adults but no significant difference was found, further there was no difference found in their coping strategies. However, older adults used problem and emotion focused engagement more than younger adults This study adds to the knowledge about spirituality among African Americans in Mississippi.

ROLE OF SELF ESTEEM AND SUICIDE IDEATION AMONG AFRICAN AMERICAN COLLEGE STUDENTs

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The average suicide rate in the U.S. is about 11 per 100,000 per year. This amounts to one completed suicide every 16 minutes according to the National Institute of Mental Health, (2008). This study was done to determine the role of self esteem in suicide ideation among 80 African American college students. Wilburm and Smith (2005) found that when self esteem increased, suicidal ideation decreased, and as stress increased self esteem also decreased, and suicidal ideation increased. Eighty students, 40 males and 40 females, were surveyed. The selection was done on a non-probability basis. The Self esteem survey used (Swahn & Behrens, 2005) has 10 items, and the Suicide Behavior Questionnaire, (Osman, 1999) has four items on different dimension of suicidality. It was hypothesized that self esteem would be positively correlated with suicide ideation. However no significant correlation was found (r=-09). Further, it was hypothesized that males would have higher self esteem than females, this hypothesis was not accepted and that females would have higher suicide ideation than males, a statistically significant difference was found however males had more suicide ideation than females (t=2.79 (78), p=.006). Self esteem needs to be raised especially for the males on this Historical Black College University (HBCU) campus. Further research needs to be done among other HBCU to validate these finding.

SCHOOLS' RACIAL COMPOSITION: STRESS, SELF-ESTEEM AND SOCIAL SUPPORT OF AFRICAN AMERICAN STUDENTS

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African American college students, in addition to general stressors, experience additional stress because of their minority status in a predominantly white environment (Greer, 2008). This study explored the difference between the stressors, self-esteem and social support of African American college students attending a Predominantly White Institution and those attending a Historically Black College and University. Perceived Stress Scale, (Cohen, 1988), Self-Esteem Inventory (Coopersmith,1978) , and Multidimensional Scale of Perceived Social Support (Zimet, Dahlem, Zimet & Farley, 1988) were administered to 80 African American students (40 attending an HBCU and 40 attending a PWI). It was hypothesized that African American students attending a HBCU would have lower stress levels, higher self-esteem and higher rates of social support than students attending a PWI. T-test results showed no significant differences in stress levels or self esteem. However, students attending HBCU had lower levels of social support (t= -1.35(78), p= .008). Further analysis to determine the nature of the social support revealed differences in support from family (p=.070) and significant others (p=.067) that were approaching significance. There were no significant gender differences. It was also hypothesized that the three variables would correlate with one another. Correlational analysis revealed negative correlations between stress and self-esteem (r= .068, p<= 0.01), stress and social support r=.348, p>.01; self-esteem and social support r= .386, p>.01. It may be concluded that social support is higher for African American students attending a PWI. Increased social support for HBCU students may result in better academic achievement and retention.

EFFECT OF CELL PHONE USEAGE UPON ENVIRONMENTAL CHANGE DETECTION.

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Cell phone usage increases accidents by 43 percent according to the American Drivers Association (2008). This experimental study conducted on forty, conveniently selected, African-American students, focused on determining the influence cell phone usage has on environmental change detection. There were four groups of ten. There were two groups of ten females, one group using a cell phone during their Change Detection experiment, and one group did not, and similarly for the males. The assignment to groups was based upon low and daily high cell phone usage. It was hypothesized that the two groups who use cell phones during the Change Detection experiment under the flicker and no flicker condition would be less likely to detect environmental change. Results showed no significant difference in reaction time for the flicker condition. For the no flicker condition the high cell usage mean reaction time was 4497.14 ms, and for the low level cell phone users 3923.5 ms (t=.813 (38), p=.036.) and this difference was significant. No gender differences were observed for both cell phone users and non cell phone users during the experimental conditions. The relevancy of this study is that it measured an individual's ability to detect changes in the environment while their attention is divided between using a cell phone and other activities and found that low cell phone users are more attentive.

COLOR OF IMPLICIT LEARNING

Ashley Hence, M.Singh
Tougaloo College, Tougaloo, MS

This study was conducted to determine the relationship of color, on implicit learning in the classroom. Implicit learning occurs when we are unaware that we are learning new information (Stadler & Frensch, 1998). Some research results Clark, 1983), indicate that colors red and white, concentrated colors, and encouraged a heightened mood which affected the ability to activate learning unconsciously evident by slower reaction time to learning the series of patterns. This experimental study was conducted on 40 conveniently selected students, 20 high school students, and 20 college students between the ages of 14-25. Participants were randomly assigned to 1 of 5 colored modules: blue, green, red, violet, and white. The data was collected using a computer generated test module on implicit learning using serial pattern learning It was hypothesized that color enriched environments will arouse attention and cognitive ability for implicit learning and that younger students will learn and perform better (as measured by response time). The analysis to determine the affect of the colored module on stimulating cognitive ability and test the participants on implicit learning was done using t-tests and ANOVA. No difference was found for implicit learning between middle school and college students, nor did color have an impact on the learning the pattern. However, implicit learning was demonstrated (t=2.64 (38), p=.012). The relationship between color and learning is acute which may result from exposure to the color stimulus however; this study was not able to establish a relationship between color and learning perhaps because of the time limit.

THE RELATIONSHIP BETWEEN PENDING LAYOFFS AND THE PSYCHOLOGICAL WELL-BEING OF THE WORKERS

Carla Coleman, Dr. Meherun Laiju
Tougaloo College, Toughaloo, MS

This paper presented the results of a survey, which examined the effects of pending layoffs on the well-being of workers. The hypothesis for this study was that there is a relationship between pending layoffs and the psychological well-being of the workers. Special attention was given to the socio-demographic characteristics of gender and age of the respondents. A survey was conducted to find out how anticipation of layoffs affected the workers. Sixty (60) workers facing pending layoffs participated in the surveys. Along with demographic questions, the survey incorporated questions from Maki, Moore, Grunberg and Greenberg (2005) work place stress & downsizing scale. The scale consisted of 22 items, which included demographic, behavioral/emotional & physical symptoms questions. The findings showed overall that the well-being of the workers was not affected. Only 38% answered yes and 62% answered no to experiencing physical symptoms. Likewise 35% experienced some form of behavioral/emotional symptoms whereas 65% did not. In contrast the gender comparison of individual indicators reflected that certain symptoms were experienced by both sexes. Particularly 54% of women and 73% men indicated feeling angry and experiencing sleep disturbances. In regard to age, women 50-59 represented the largest age group of participants. The results revealed that 9 out of 13 women felt angry. Men age 30–39 and 40-49 indicated that men also experienced anger. Anger emerged as the significant indicator. This and other isolated indicators pinpoint warning signs that alert possible dangerous situations in businesses and to the individuals themselves.

SOCIOECONOMIC FACTORS INFLUENCING DISPARITIES IN IMMUNIZATION: A META-ANALYSIS OF NIS/NHIS STUDIES

Tiffany Trowles, Dr. Meherun Laiju
Tougaloo College, Tougaloo, MS

In this paper the researcher explored the socioeconomic factors that influence disparities in immunization. The researcher used the Health Behavior Model (HBM) as a framework. A meta-analysis was used to examine socioeconomic factors that contribute to increasing or decreasing disparities in up-to-date immunization among children ages 19-35 months to find which factors were statistically significant. The study included eight articles

that were found using the key words “health disparities” and “immunization” through the SocINDEX, Social Science Citation Index, or Academic Search Premiere (Ebsco Host) databases with publication dates ranging from 2000 to 2010. The articles found all utilized data from the National Immunization Survey or the National Health Interview Survey and used logistic regression to compare variables which included: the vaccine ratio; race/ethnicity; poverty level; mother’s marital status, educational level, and age; number of children in the household; if the child was the first born; region of the United States they resided in; urbanicity; WIC participation; insurance status; type of medical facility being used; number of pediatricians available in the area; number of providers seen; and the provider’s characteristics. The findings revealed that race, poverty level, mother’s characteristics, and insurance status, amongst other factors affected the disparities in immunization either positively or negatively. It is suggested that various analyses, such as in-depth interviews and more attention to interaction effects, should be done on the significant factors in the research that was examined in this meta-analysis in order to make changes that will one day eliminated the immunization disparity

Division Reports:

REPORT OF THE ZOOLOGY AND ENTOMOLOGY DIVISION OF THE MISSISSIPPI ACADEMY OF SCIENCES ON THE 59TH ANNUAL CONFERENCE OF THE ACADEMY HELD AT THE UNIVERSITY OF SOUTHERN MISSISSIPPI IN HATTIESBURG, MS FROM FEB. 17 – 18, 2011.

The Division's sessions were held on Thursday and Friday. It featured two posters and 11 oral variety presentations which included a symposium on Water Quality of the Lower Mississippi River. About 20 individuals attended the presentations. The papers presented were interesting and thought-provoking. The comments, questions, and answer periods were lively with relevant questions asked . They generated thoughtful discussions.
At the end of the business meeting, Dr. Alex D. W. Acholonu from Alcorn State University was re-elected the Chair of the Division and Dr. Julius Ikenga, of Mississippi Valley State University was re-elected the Vice Chair.
It has been a pleasure to serve as the Chair of the Division and an honor to be re-elected as chair of the Division.
A group picture of some of those who attended the presentations of the Zoology and Entomology Division appears below.

Alex D. W. Acholonu, PhD, FAS, OON
Professor of Biology and Chair, Zoology and Entomology Division, MAS

Health Sciences:Division Winners

Graduate Winners:

First Place	David Black, University of Mississippi Medical Center, SOM
First Place	Hillary Sartin, University of Mississippi Medical Center, SOD
Second Place	Gerri Wilson, Millsaps College and Univeristy of Mississippi Medical Center
Third Place	Erin Wiggers, University of Mississippi Medical Center, SOM

Chemistry and Chemical Engineering Division Winners

Cash Awards were provided by the Department of Chemistry and Biochemistry at Jackson State University

Kimberly Simmons, Willaim Carey University
Toyketa Horne, Jackson State University
Sadia Kahn, Jackson State University
Caitlyn Shirley, University of Southern MS
Phillip Schwartz, Millsaps
Mary Mackey, University of Southern MS

Pschyology and Social Science DivisionWinners

Cash Awards were provided by Drs. Shaila Kahn and Sherre Watson

Kevin Karl, Ole Miss
Davis Hambury , University of Southern MS
Telethia Rogers, Tougaloo
Jeffrey Auerbach, University of Southern MS
Alyce Mack, Tougaloo

MEMBER RECOGNITION

The Acadmey would like to recognize the following individuals for their acheivements.

Dr. Girish Panicker receives "Pride of India" award

Girish Kumar Panicker, director of Conservation Research, Mississippi, an authority on C-factor (cover and management) research and a renowned agricultural scientist, was honored during India's annual event for its international diaspora, held in January, 2011. This prestigious award is conferred to distinctive non-resident Indians for their valuable contribution, dedication, and remarkable services that give India reasons to be proud of them. His Highness Dr. Karan Singh, King of Jammu-Kashmir, Chairman of Indian Council for Cultural Relations, former Indian ambassador to the U.S, and former Foreign minister of India presented Panicker with the award.

A native of Kerala state of India and an alumnus of Mississippi State University, Panicker earned his PhD in horticulture with 'Dr. Joseph B. Edmond Award' for outstanding achievement in graduate school. He is a Certified Professional Agronomist (CPAg) and has worked largely in conservation field on three continents, Asia, Africa and the North America, and has been providing free consultancy services to research organizations and universities in several countries. As the director of Conservation Research at Alcorn state University, his federally funded research center has the world's largest data bank on horticultural crops, with work done on 36 crops at an investment of more than $5 million. The information generated addresses erosion prediction, nutrient management and conservation planning as well as prevention of soil erosion and climate damage. Panicker's advanced research methodologies on sustainable and organic production practices with plant residues and animal waste for a healthier environment are being podcasted internationally by the American Society for Horticultural Science (ASHS).

Panicker's research collaborators include scientists of the Natural Resources Conservation Service and Agricultural Research Service of the USDA, the US Army, and land-grant universities. An active member of the ASA for the last 27 years, Panicker has been member of numerous national and international agriculture societies, including ASHS, ISHS, SWCS, WASWC, during his international career. He has served as the chairman of the National Committee for Publication Awards of the ASHS and chairman of the division of Agriculture of Mississippi Academy of Sciences. Currently, he is an advisory committee member of the National Organic Farming Research Foundation.

Girish K. Panicker resides in Vicksburg, MS, with his wife Rani and daughter Gem.

The Academy would like to recognize Dr. Alex D.W. Acholonu for his services to the community

Medical Mission

REPORT ON FREE MEDICAL MISSION AND HIV/AIDS SCREENING CONDUCTED AT AWAKA IN OWERRI NORTH LOCAL GOVERNMENT AREA(LGA) IMO STATE, NIGERIA ON DECEMBER 22 – 23, 2010

BY

Alex D. W. Acholonu, PhD, FAS OON
Professor of Biology
Alcorn State University
Alcorn State, MS 39096
and
Founder/President and CEO
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INTRODUCTION

During the Board meeting of the Mississippi Academy of Sciences held in October, 2010,
I announced my plan to conduct a free medical mission at Awaka, in Owerri North Local Government Area(LGA) in Imo State, Nigeria in December, 2010 under the auspices of the Willy-Esther Foundation. During the Board meeting of January, 2011(after the medical mission), I reported on the medical mission to the Board and passed around an album of pictures taken during the medical mission. I was requested by the Executive Director to submit a write-up on this medical mission and make available some pictures for possible publication, hence this report.

The following is a synopsis of the medical mission event.

The purpose of the medical mission was to show compassion for the needy in this developing country, Nigeria; to give hope to the hopeless; to contribute our quota in the effort to eradicate HIV/AIDS in Nigeria with main focus on the rural areas. This is why our slogan is **PROJECT: DELTA**(doing everything *LOCALLY* to stop AIDS). It was national two days of service for HIV/AIDS; healing the land through HIV/AIDS awareness.

The two-day program(Dec. 22-23, 2010) started with an opening ceremony which, among other things, featured the following: Remarks by the Chair of the occasion, Prof. Chidi Akujor, a Professor and Director of Information and Communication Technology, Federal University of Technology, Owerri; Remarks from Dr.Ethelbert Anyanwu , the State Agency for the Control of HIV/AIDS(SACA), the Honorable Commissioner of Health, Hon.. Fredric Ekwem, the reading of Governor Ikedi Ohakims 's speech and the official opening of the free medical mission by his representative, the Permanent Secretary, Ministry of Health, Mr. Victor Onyeagoro.. The Federal Government of Nigeria at the Federal Capital, Abuja, was represented in the person of Prof. John Idoko, the Director General of the National Agency for the Control of AIDS(NACA) and Dr. Prosper Okonkwo, CEO of AIDS Prevention Initiative of Nigeria(APIN)).

The opening ceremony was climaxed with a distinguished service award given to me(Dr. Alex D. W. Acholonu) after a citation of my achievements by Evangalist. Peter Chima, the President of Awaka Go-forward International Center for Youth Development, a non-profit organization(NGO) based at Awaka and familiar with me, my activities in the community and my professional accomplishments. Part of the inscription on the plaque given to me was that it was presented to me ***"in recognition of his support, excellent service to development of education, health, community, youth and HIV/AIDS prevention in society".***

The medical mission activities started in earnest after the Governor, through his representative, declared the medical mission open with cutting of the ribbon. The activities conducted included counseling, testing, that included malaria, cholesterol, blood pressure, blood glucose , urinalysis, hepatitis B and HIV/AIDS screening. Blood was also taken for subsequent testing for *Toxoplasma gondii* infection, a frequent opportunistic infection in HIV positive subjects. Those who came, were clinically examined by doctors and prescribed medicines were given to them in the pharmacy section by Dr. Wilfred W. Acholonu Jr., a clinical pharmacist at the Veteran Administration Hospital in Gainesville, Florida. Left-over drugs were left with Dr. Lambo, Igwe who operates a health clinic at Awaka to continue to give them freely to the poor and the needy with courtesy of the Willy-Esther Foundation, Inc.

Dr. Ambrose Opara, a senior lecturer at Evan Enwerem University(formerly, Imo State University) and his medical technology students ably took care of the diagnostic aspects of the medical mission. The Governor of Imo State, Chief Dr. Ikedi Ohakim, provided security by sending policemen to be bodily present throughout the duration of the medical mission.

CONCLUSION

About 300 people were treated during the medical mission at Awaka. Of those who volunteered to be screened for HIV/AIDS, two were positive and were referred to Government for follow-up action. Many people expressed profound gratitude for our coming to Awaka to conduct the free medical mission and free screening for HIV/AIDS. They passionately requested that I make is a yearly affair.

ACKNOWLEDGMENTS

I wish to express my gratitude to Wal-Mart represented by the Wal-Mart Manager in Vicksburg, Mr. Roger Washington, Piggly Wiggly of Port Gibson, Rite Drugs of Port Gibson, Family Health Center of Port Gibson represented by Mr. Marvell Spears, Men's Club of St Mary's Catholic Church, Building Bridges, Inc. of Jackson, several individuals from St Mary's Catholic Church my colleagues from Alcorn State University and other individuals in and out of the State of Mississippi who through their donations made this free medical mission a great success. I am grateful to Dr. Prosper Okonkwo who not only honored the medical mission with being bodily present but give manpower and financial support . I am also grateful to the Archbishop of the Diocese of Owerri, His Grace Anthony Obinna represented by Rev. Sister Nwokoloku, in charge of HIV?AIDS operations in the Owerri Diocese. Above all, I am grateful to the Governor of Imo State for his elevating speech, and his over-all contribution in making the medical mission more appreciable.

SUPPLICATION

Those interested in joining us next time are requested to please let us know and join us. Those who can give donation of drugs, laboratory supplies and financial support are requested to please do so. They should contact me at chiefacholonu@yahoo.com or call
601-636-5903.

Chief Prof. Acholonu proudly displays the precious award given to him

Leading by example, Prof Acholonu conducts a blood sugar test on one of the lab technologists

SEVENTY SIX ANNUAL MEETING

LAKE TERRACE CONVENTION CENTER

HATTIESBURG, MS

February 23-24, 2012

More Information will be available in the October issue

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- Enclose a personal check, money order, institutional check, or purchase order for $25 publication charge for each abstract to be published, payable to the Mississippi Academy of Sciences. The publication charge will be refunded if the abstract is not accepted.
- The presenting author must be a member of the Academy at the time the paper/poster is presented. Payment for membership of one author must be sent for the abstract to be accepted.
- Attendance and participation at all sessions requires payment of registration.
- Note that three separate fees are associated with submitting and presenting a paper at the annual meeting of the Mississippi Academy of Sciences.
    1. An abstract fee is assessed to defray the cost of publishing abstracts and
    2. a membership fee is assessed to defray the costs of running the Academy.
    3. Preregistration payment ($25 regular; $10 student) may accompany the abstract, or you may elect to pay this fee before February 1, or pay full registration fees at the meeting.
- Abstracts may **only** be submitted on line via a link through the MAS website.The appropriate abstract fees can be paid via Paypal or sent via mail to Barbara Holmes at the Academy address .
- **Late abstracts will be accepted with a $10 late fee during November increased to $25 after that. Late abstracts will be accepted only if there is room in the appropriate division. They will be published in the April issue of the MAS JOURNAL.**
- Submit your appropriate fees NO LATER THAN NOVEMBER 1, 2011.

Ms. Barbara Holmes
Mississippi Academy of Sciences
Post Office Box 55907
Jackson, MS 39296-5907

GUIDELINES FOR POSTER PRESENTATIONS

- The Academy provides poster backboards. Each backboard is 34" high by 5' wide. Mount the poster on the board assigned to you by your Division Chairperson. Please do not draw, write, or use adhesive material on the boards. You must provide your own thumb tacks.
- Lettering for your poster title should be at least 1" high and follow the format for your abstract. Lettering for your poster text should be at least 3/8" high.
- Posters should be on display during the entire day during which their divisional poster session is scheduled. They must be removed at the end of that day.
- Authors must be present with their poster to discuss their work at the time indicated in the program.

Supplementary Material for "A review of native vegetation types in the Black Belt of Mississippi and Alabama, with suggested relationships to the catenas of soil series": general characteristics of soil series, plus general interpreted relationships with topography and presettlement vegetation.

The charts below include virtually all soil series that occur in the Black Belt region of Mississippi and in transitions to the Pontotoc Ridge (with more sand, overlying the chalk). Excluded here are more sandy or acid soils associated with other sections of the Gulf Coastal Plain: e.g., Smithdale, Luverne, Ruston, Providence, Lexington (uplands); and Bibb, Tuka, Urbo (lowlands).
See paper for complete bibliography. Most data come from the following two sources.

U.S.D.A. Natural Resources Conservation Service [NRCS]. 2010a. Official Soil Series Descriptions (OSD) with series mapping capabilities [http:// soils.usda.gov/technical/ classification/osd/index.html].

U.S.D.A. Natural Resources Conservation Service [NRCS]. 2010b. Soil Surveys for Counties of the U.S.A. [http:// websoilsurvey.nrcs.usda.gov/app/ WebSoilSurvey.aspx].

Explanation of format for data on soils.

First line.
(a) Soil class, with preceding abbreviations for modifiers: a = alfic; ch = chromic; cu = cumulic; d = dystric; f = fluventic; fa = fluvaquentic; h = humic; le = leptic; li = lithic; m = mollic; o = oxyaquic; q = aquic; r = rendollic; t = typic; v = vertic.
(b) At right margin, color of A horizon is coded using following symbols:
b = brown; d = dark; g = gray(ish); l = light; m = mottled; o = olive; r = red(dish); v = very dark; y = yellow(ish).

Second line.
(a) Name of soil series, with abbreviations for typical texture (excluding eroded clayey phases on steeper slopes) as follows:
c = clay; csl = cherty silt loam; fsal = fine sandy loam; l = loam; sa = sand; sic = silty clay; sicl = silty clay loam; si = silt; sil = silt loam; shsil = shaly silt loam; rl = rocky loam (or complex mixture); rsic = rocky (or flaggy) silty clay.
(b) At right margin, color of mid-to-upper B horizon is coded using same symbols as listed under First Line (b).

Third line.
(a) Typical slope in percent; followed by typical depth to bedrock in feet.
(b) At left margin, asterisks (*) indicate that slopes are locally steep enough for significant differences in soil and vegetation on N/NE-facing versus S/SW-facing aspects.
(c) At right margin, general drainage class is coded as follows: 1 = very poorly drained; 2 = poorly drained; 3 = somewhat poorly drained; 4 = moderately well-drained; 5 = well-drained; 6 = somewhat excessively drained; 7 = excessively drained.

Fourth line.
(a) Parent material, with abbreviations as follows: >> = thick loess mantle; > = thin or patchy loess mantle; As = acid shale; Ca = acid clay; Cc = calcareous clay (often mixed with Ch); Ck = chalky limestone (with marl); Ct = cherty limestone; Cs = calcareous shale; Li = limestone (arg = argillaceous); Sa = sandstone; Sh = shale (undifferentiated),
(b) Followed by topographic context: bot = bottomland (with generally fresh alluvium); col = colluvium; dep = alluvial depression (tending to sla); flu = fluvial; fin = fine-textured; mar = marine; med = medium-textured; pon = ponded alluvium (tending to sla); res = residuum; sla = slack-water deposits (with fine-textured alluvium on bottomlands, terraces or locally uplands); ter = terrace (with generally weathered alluvium); upl = uplands (often with undifferentiated residuum or colluvium).
(c) At right margin, typical pH of topsoil (ca. 0-8 inches deep), with coding as follows: A = 4.5-5 (very strongly acid); B = 5.1-5.5 (strongly acid); C = 5.6-6 (medium acid); D = 6.1-6.5 (slightly acid); E = 6.6-7.3 (circumneutral); F = 7.3-8 (alkaline).
Note: in most cases pH is less in mid to low horizons by up to 1 unit or so; > indicates a strong trend in this direction; < indicates the opposite trend; ~ indicates much variation without overall trend.

Composite chart with soil data; see explanation on previous page.
Blue-shaded soil series are mapped at the Pulliam Prairie (darker) or nearby (lighter) in Chickasaw County; others may well occur there locally, including intermediate soils between the standard series. Green-shaded soil series are additional soils mapped at significant vegetation in Oktibbeha County: the Sand Creek Chalk Bluff (Morris et al. 1993), the Osborn Prairie (Leidolf and McDaniel 1998) and adjacent oak woods (Hill et al. 2009); note that much Savannah is on exogenous fine sandy terraces. The mapped soils at these Oktibbeha County sites overlap to a limited extent with the Pulliam Prairie: they do include Kipling, Leeper and Catalpa in common.

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		t-Kandiudult b Faceville fsal r 0-15; >60 5 old mar/flu clay B	g-Fragiudult db Prentiss lo yb 0-8; >60 4 old mar/flu ter B>	fa-Paleudult vdg Brewton fsal yb 0-4; 60-80 3 old mar/flu ter B>	t-Paleaquult vdg Trebloc sil g/ybm 0-2; 60-80 2 old mar/flu dep A
Sandy uplands or high terraces: sandy loams to fine sandy loams		t-Fragiudult vdgb Ora sal yr 0-12; >60 4 old mar/flu ter B	t-Fragiudult dgb Savannah fsal yb 1-15; 50-80 4 old mar/flu ter B>	fa-Paleudult dgb Stough fsal yb 0-5; >60 3 old mar/flu ter B>	Note: Brewton is close to Stough but more eluviated (in A2/E horizons)
Clayey uplands: acid clay and locally sand or silt overlying chalk	u-Hapludalf b Brantley fsal db *0-35; 40-60 5 upl: med-fin D>	v-Paleudalf dgb Boswell fsal r 1-17; >60 4 Ca upl B	v-Paleudalf dg Kipling sil yb *0-40; 40-80 3 Ca upl/ter C>	a-Hapludert vgb Brooksville sicl dgb 0-5; 40-70 3 Ca upl C<	ch-Dystraquept vg Eutaw sic yb 0-2; c. 80 2 Ca upl A>
Clayey uplands: acid clay overlying chalk; not loamy		le-Hapludert dyb Watsonia c yr *1-25; 10-20 5 Ca upl C<	ch-Dystrudert db Oktibbeha c yb *1-30; 60-80 4 Ca upl D>	a-Dystrudert vgb Vaiden c yb 0-5; 60+ 3 Ca upl/ter D>	
Chalky uplands: gentle slopes with influence of overlying clay		o-Hapludert o Maytag sic og 1-12; 45-60 5 Ck upl E	o-Hapludert vgb Okolona sic o 0-5; 40-65 5 Cc upl E	o-Hapludert vg Houston cl og 0-8; 50-100 4 Cc upl E	Note: "Houston" has often eroded down to Sumter (Gibson 1941)
Chalky uplands: steeper side-slopes to local alluvial flats with clay	t-Haprendoll vdg Binnsville sic log 1-17; 7-20 5 Ck upl F	r-Eutrudept gb Sumter sic lyb *1-40; 20-40 5 Ck upl F	a-Hapludert dog Griffith sic og 0-2; c. 60 4 Cc all F	ch-Epiaquert dyb Sucarnochee sic og 0-2; 60+ 3 Cc all E	
Chalky uplands: loamy toe-slopes, swales and alluvial lowlands	Note: undescribed soil here on mesic NE-facing bluffs with sugar maple	t-Udorthent dgb Demopolis sicl dgb *1-35; 10-20 5 Ck upl F	a-Hapludert vgb Faunsdale cl lob 0-5; 60+ 3 Cc toe E	v-Epiaquept dgb Leeper sicl dgb 0-3; 20-60 3 Cc all F	
Floodplains: loamy alluvium along perennial streams			fa-Hapludert b Marietta l dgb 0-2; 30-60 4 loamy all E	a-Fluvaquent dgb Belden sicl gb 0-2; 45-60 3 silty/loamy all D	Note: more open marshy wetland soils need definition here
Floodplains: deep clayey alluv. along streams and backwater sloughs		t-Hapludert vdg Trinity c dog 0-3; >80 5 clayey all F	fa-Hapludoll vgb Catalpa sicl dgb 0-3; 60+ 3/4 clayey all E	v-Epiaquept vgb Tuscumbia sicl g 0-2; >50 2 clayey all D~	t-Epiaquept vgb Una sic lb 0-4; >60 2 acid clayey all B<

Broad Soil Classes.

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		Ultisol	Ultisol	Ultisol	Ultisol
Sandy uplands or high terraces: sandy loams to fine sandy loams		Ultisol	Ultisol	Ultisol	
Clayey uplands: acid clay and locally sand or silt overlying chalk	Alfisol	Alfisol	Alfisol	Vertisol	Inceptisol
Clayey uplands: acid clay overlying chalk; not loamy		Vertisol	Vertisol	Vertisol	
Chalky uplands: gentle slopes with influence of overlying clay		Vertisol	Vertisol	Vertisol	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	Mollisol	Inceptisol	Vertisol	Vertisol	
Chalky uplands: loamy toe-slopes, swales and alluvial lowlands	to be described: mesic NE-facing bluff with sugar maple	Entisol	Vertisol	Inceptisol	
Floodplains: loamy alluvium along perennial streams			Vertisol	Entisol	
Floodplains: deep clayey alluv. along streams and backwater sloughs		Vertisol	Mollisol	Inceptisol	Inceptisol

Soil Texture of A horizon.

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		**fine sandy loam**	**loam**	**fine sandy loam**	**silt loam**
Sandy uplands or high terraces: sandy loams to fine sandy loams		**sandy loam**	**fine sandy loam**	**fine sandy loam**	
Clayey uplands: acid clay and locally sand or silt overlying chalk	**fine sandy loam**	**fine sandy loam**	**silt loam**	**silty clay loam**	**silty clay**
Clayey uplands: acid clay overlying chalk; not loamy		**clay**	**clay**	**clay**	
Chalky uplands: gentle slopes with influence of overlying clay		**silty clay**	**silty clay**	**clay**	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	**silty clay**	**silty clay**	**silty clay**	**silty clay**	
Chalky uplands: loamy toe-slopes, swales and alluvial lowlands		**silty clay loam**	**clay loam**	**silty clay loam**	
Floodplains: loamy alluvium along perennial streams			**loam**	**silty clay loam**	
Floodplains: deep clayey alluv. along streams and backwater sloughs		**clay**	**silty clay loam**	**silty clay loam**	**silty clay**

Average Slope: degrees.
Note that in all soil series, slope varies greatly, with some present on more or less level ground (with 0-3% slope) in each case. The more sloping variants of each soil series are often present at eroding edges of more gentle slopes or flats.

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		7	5	2	1
Sandy uplands or high terraces: sandy loams to fine sandy loams		6	4	3	
Clayey uplands: acid clay and locally sand or silt overlying chalk	17	9	20	3	1
Clayey uplands: acid clay overlying chalk; not loamy		15	15	3	
Chalky uplands: gentle slopes with influence of overlying clay		6	3	4	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	10	20	1	1	
Chalky uplands: loamy swales, toe-slopes and alluvial lowlands		20	3	1	
Floodplains: loamy alluvium along perennial streams			1	1	
Floodplains: deep clayey alluv. along streams and backwater sloughs		2	2	1	2

Average Depth of Soil (to bottom of C horizon): inches

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		70	70	70	70
Sandy uplands or high terraces: sandy loams to fine sandy loams		70	70	70	
Clayey uplands: acid clay and locally sand or silt overlying chalk	50	65	60	55	80
Clayey uplands: acid clay overlying chalk; not loamy		15	70	70	
Chalky uplands: gentle slopes with influence of overlying clay		52	52	75	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	15	30	60	70	
Chalky uplands: loamy swales, toe-slopes and alluvial lowlands		15	60	40	
Floodplains: loamy alluvium along perennial streams			45	52	
Floodplains: deep clayey alluv. along streams and backwater sloughs		80+	70	70	70

Drainage Classes: 5 = well-drained; 4 = moderate; 3 = somewhat poorly; 2 = poorly drained; 1 = very poorly drained.

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		5	4	3	2
Sandy uplands or high terraces: sandy loams to fine sandy loams		4	4	3	
Clayey uplands: acid clay and locally sand or silt overlying chalk	5	4	3	3	2
Clayey uplands: acid clay overlying chalk; not loamy		5	4	3	
Chalky uplands: gentle slopes with influence of overlying clay		5	5	4	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	5	5	4	3	
Chalky uplands: loamy swales, toe-slopes and alluvial lowlands		5	3	3	
Floodplains: loamy alluvium along perennial streams			4	3	1? (ponds)
Floodplains: deep clayey alluv. along streams and backwater sloughs		5	3-5	2	2

Typical pH of upper (A) horizon: A = 4.5-5; B = 5.1-5.5; C = 5.6-6; D = 6.1-6.5; E = 6.6-7.5; F = 7.6-8.5
Note: in most cases pH is less in mid to low horizons by 0-1 units;
">" indicate a strong trend; "<" indicates the opposite trend; "~" = highly variable

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		B	B>	B>	A
Sandy uplands or high terraces: sandy loams to fine sandy loams		B	B>	B>	
Clayey uplands: acid clay and locally sand or silt overlying chalk	D>	A	C>	C<	A> (4-4.5 below)
Clayey uplands: acid clay overlying chalk; not loamy		C<	D>	D>	
Chalky uplands: gentle slopes with influence of overlying clay		E	E	E	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	F	F	F	E	
Chalky uplands: loamy swales, toe-slopes and alluvial lowlands		F	E	F	
Floodplains: loamy alluvium along perennial streams			E	D	
Floodplains: deep clayey alluv. along streams and backwater sloughs		F	E	D~	B<

Typical color of upper A horizon (topsoil); color graphic balances as follows in Microsoft Word (red-yellow-blue).
r: 255 0 0; yr: 255 153 0; dyb: 144 123 0; yb: 204 153 0; lyb: 184 158 0; db: 105 51 0; b: 164 82 0; lb: 176 117 58;
dob: 178 131 0; lob: 217 160 56; o: 204 153 0; oy: 204 180 0; dog 178 131 0; og 175 159 64; log 191 175 81;
vdgb: 81 63 49; dgb: 107 83 65; gb: 139 108 85; vdg: 51 51 51; dg: 76 76 76; g: 100 100 100

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		brown	dark brown	very dark gray	very dark gray
Sandy uplands or high terraces: sandy loams to fine sandy loams		very dark gray brown	dark gray brown	dark gray brown	
Clayey uplands: acid clay and locally sand or silt overlying chalk	brown	dark gray brown	dark gray	very dark gray brown	very dark gray
Clayey uplands: acid clay overlying chalk; not loamy		dark yellow brown	dark brown	very dark gray brown	
Chalky uplands: gentle slopes with influence of overlying clay		olive	very dark gray brown	very dark gray	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	very dark gray	gray brown	dark olive gray	dark yellow brown	
Chalky uplands: loamy swales, toe-slopes and alluvial lowlands		dark gray brown	very dark gray brown	dark gray brown	
Floodplains: loamy alluvium along perennial streams			brown	dark gray brown	
Floodplains: deep clayey alluv. along streams and backwater sloughs		very dark gray	very dark gray brown	very dark gray brown	very dark gray brown

Typical color of mid-upper B horizon (usually ca. 10-40 inches deep).
r: 255 0 0; yr: 255 91 0; dyb: 144 123 0; yb: 204 153 0; lyb: 184 158 0; db: 105 51 0; b: 164 82 0; lb: 176 117 58;
dob: 178 131 0; lob: 217 160 56; o: 204 153 0; oy: 204 180 0; dog 178 131 0; og 175 159 64; log 191 175 81;
vdgb: 81 63 49; dgb: 107 83 65; gb: 139 108 85; vdg: 51 51 51; dg: 76 76 76; g: 100 100 100

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		red	yellowish brown	yellowish brown	gray w/yb mottle
Sandy uplands or high terraces: sandy loams to fine sandy loams		yellowish red	yellowish brown	yellowish brown	
Clayey uplands: acid clay and locally sand or silt overlying chalk	dark brown	red	yellowish brown	dark grayish brown	yellowish brown
Clayey uplands: acid clay overlying chalk; not loamy		yellowish red	yellowish brown	yellowish brown	
Chalky uplands: gentle slopes with influence of overlying clay		olive yellow	olive	olive gray	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	light olive gray	light yellowish brown	olive gray	dark grey	
Chalky uplands: loamy swales, toe-slopes and alluvial lowlands		dark grayish brown	light olive brown	dark grayish brown	
Floodplains: loamy alluvium along perennial streams			brown	grayish brown	tbd: mottled?
Floodplains: deep clayey alluv. along streams and backwater sloughs		dark olive gray	dark gray brown	gray	light brown

Typical land use (upper line): cotton, corn, peanuts, soybeans, small grains, oil-seed, hay, pasture, prairie, forest/woodland. Numbers below are provisional data on corn bushels per acre (from 1960 Soil Survey of Montgomery County, Alabama).

TYPICAL TOPO-GRAPHY	MORE HILLY LANDSCAPES IN GENERAL shallow/rocky soil		INTERMEDIATE LANDSCAPES IN GENERAL moderate to deep		LESS HILLY LANDSCAPES IN GENERAL less well-drained
Mixed uplands or high terraces: fine sandy loams to silt loams		**cot,cor,pea**	**cot,cor,soy 25-50**	**for**	**for (willow oak+)**
Sandy uplands or high terraces: sandy loams to fine sandy loams		**cot,cor,smg**	**cot,cor,soy**	**for,pas 15-35**	
Clayey uplands: acid clay and locally sand or silt overlying chalk	**cot,soy,pas**	**for,pas 12-30**	**cot,soy,smg 15-40**	**cot,soy,sor**	**for (post oak+) 15-25**
Clayey uplands: acid clay overlying chalk; not loamy		**pas,hay,soy**	**for,pas,cot 15-30**	**cot,soy,cor 12-40**	
Chalky uplands: gentle slopes with influence of overlying clay		**pas,soy,sor**	**cot,soy,sor**	**pas,hay,soy 30-60**	
Chalky uplands: steeper side-slopes to local alluvial flats with clay	**pra,woo**	**pas,hay,smg 10-35**	**cot,cor,soy**	**pas,oil (for 5%)**	
Chalky uplands: loamy swales, toe-slopes and alluvial lowlands	**for?**	**pas,hay**	**cot,pas,soy**	**cot,cor,soy 25-60**	
Floodplains: loamy alluvium along perennial streams			**cot,soy,cor**	**cot,cor,soy**	**for/pas? +ponds**
Floodplains: deep clayey alluv. along streams and backwater sloughs		**pas,cot,cor**	**pas,hay,cot**	**for,pas 15-40**	**for,pas 10-30**